Volume II, No. 2

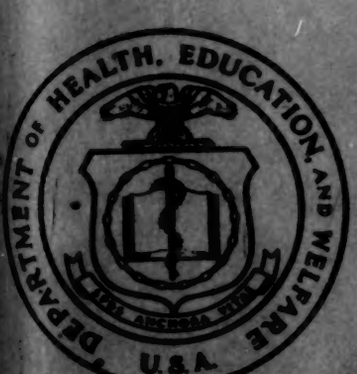
PB 161371-11

4 MAR 1 2
COPY 2

RADIOLOGICAL HEALTH DATA

MONTHLY REPORT

February 1961



U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service

Distributed by U.S. Department of Commerce, Office of Technical Services, Washington 25, D.C.,
Price $1 single issue, $9 for one year ($2.50 additional for foreign mailing).

RADIOLOGICAL HEALTH DATA

MONTHLY REPORT

FEBRUARY 1961

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service

Division of Radiological Health

PREFACE

In August 1959, the President directed the Secretary of Health, Education, and Welfare to intensify Departmental activities in the field of radiological health. The Department was assigned responsibility within the Executive Branch for the collation, analysis, and interpretation of data on environmental radiation levels. The Department delegated this responsibility to the Division of Radiological Health, Public Health Service.

Radiological Health Data is published by the Public Health Service on a monthly basis. Data is provided to the Division of Radiological Health by other Federal agencies, State health departments, and by foreign governments. Except where material is directly quoted, summaries are prepared by the staff of the Division of Radiological Health. The reports are reviewed by a Board of Editorial Advisors with representatives from the following Federal agencies:

Department of Health, Education, and Welfare
Atomic Energy Commission
Department of Defense
Department of Commerce
Department of Agriculture

TABLE OF CONTENTS

	Page
PREFACE	iii
SECTION I.—AIR	
Public Health Service Radiation Surveillance Network	61
Radioactivity of Particulates in Air (September 1960)	63
Radon and Thoron Measurements (September 1960)	64
Naval Research Laboratory Radioactivity Measurements	64
Daily Record of Fission Product Beta Activity (September 1960)	65
Profile of Beta Activity	67
SECTION II.—FOOD, OTHER THAN MILK	
The Annual and Geographical Influences on the Strontium-90 Intake in Japanese Diet—Nutrition Division, Japanese Ministry of Public Health	68
SECTION III.—MILK	
Public Health Service Milk Monitoring Program	72
Radioactivity in Milk (September 1960)	74
SECTION IV.—WATER	
Public Health Service National Water Quality Network	77
Radioactivity in Raw Surface Waters (August 1960)	79
SECTION V.—OTHER DATA	
External Gamma Activity (September 1960)—Public Health Service Radiation Surveillance Network	82
Radioactive Contamination of Jet Aircraft	83
Off-Site Animal Investigation Project—Atomic Energy Commission	89
Human Bone Sampling Program of the Canadian Radioactive Fallout Study Program	96
Long Term Training Activities of the Division of Radiological Health	102
Environmental Levels of Radioactivity at Atomic Energy Commission Installations	102
Aircraft Nuclear Propulsion Department	102
Brookhaven National Laboratory	106
Connecticut Aircraft Nuclear Engine Laboratory	106
National Reactor Testing Station	119

For personal and extra subscriptions to ***Radiological Health Data***, use the handy order form on page 61.

SECTION I.—AIR

PUBLIC HEALTH SERVICE RADIATION SURVEILLANCE NETWORK

The Public Health Service Radiation Surveillance Network was established in 1956 in cooperation with the Atomic Energy Commission to provide a means of promptly determining increases in environmental radiation due to radioactive fallout during nuclear weapons tests. The program has proven sufficiently valuable that it has been extended to a round-the-year basis and currently consists of 45 stations at urban locations (see figure 1) operated by State and local health department personnel with 2 operated by U. S. Public Health Service personnel.

Measurements of gross beta radioactivity in air have been taken since they provide one of the earliest and most sensitive indications of increases of activity in the environment, and thus act as an "alert" system. A direct evaluation of biological hazards is not possible from these data alone. However, field measurements do enable the operator to estimate the amount of beta activity of particulates in the air at the station five hours after collection, by comparison to a known source, using a portable survey meter. The filters are then forwarded to a laboratory in Washington, D. C., for more refined measurement with a thin window proportional counter.

Air samplers are in operation at the 45 stations on an average of 70 percent of the week. Air is drawn through a cellulose carbon loaded dust filter using a high volume air sampler. The radioactive material in fallout adhering to small dust-like particles is retained on the filter. Some gaseous fission products are adsorbed by the carbon. The contribution by gaseous fission products has represented only a small part of the total beta activity in these samples.

About 85 percent of the stations collect samples of precipitation which are sent to Washington, D. C. for analysis. Values are now below limits of detection by present instrumentation. New equipment is being procured to measure lower values. Measurements have indicated that the bulk of deposited activity occurs through precipitation but concentrations in surface air are not directly relatable to the amount deposited through precipitation.

Table 1 presents a summary of the latest monthly data on gross beta radioactivity. Table 2 presents daily measurements of radon, thoron, and gross beta activity at the Cincinnati, Ohio, station.

Order Form

U. S. Department of Commerce
Office of Technical Services
Washington 25, D. C.

Radiological Health Data
$9 for 1 year—Single Copy $1
($2.50 additional for foreign mailing)

Please enter my subscription for PB 161371 for_____ years (1, 2 or 3 years). I enclose my check for_____to OTS, U. S. Department of Commerce, Washington 25, D. C.

Name_____

Organization_____

Address_____

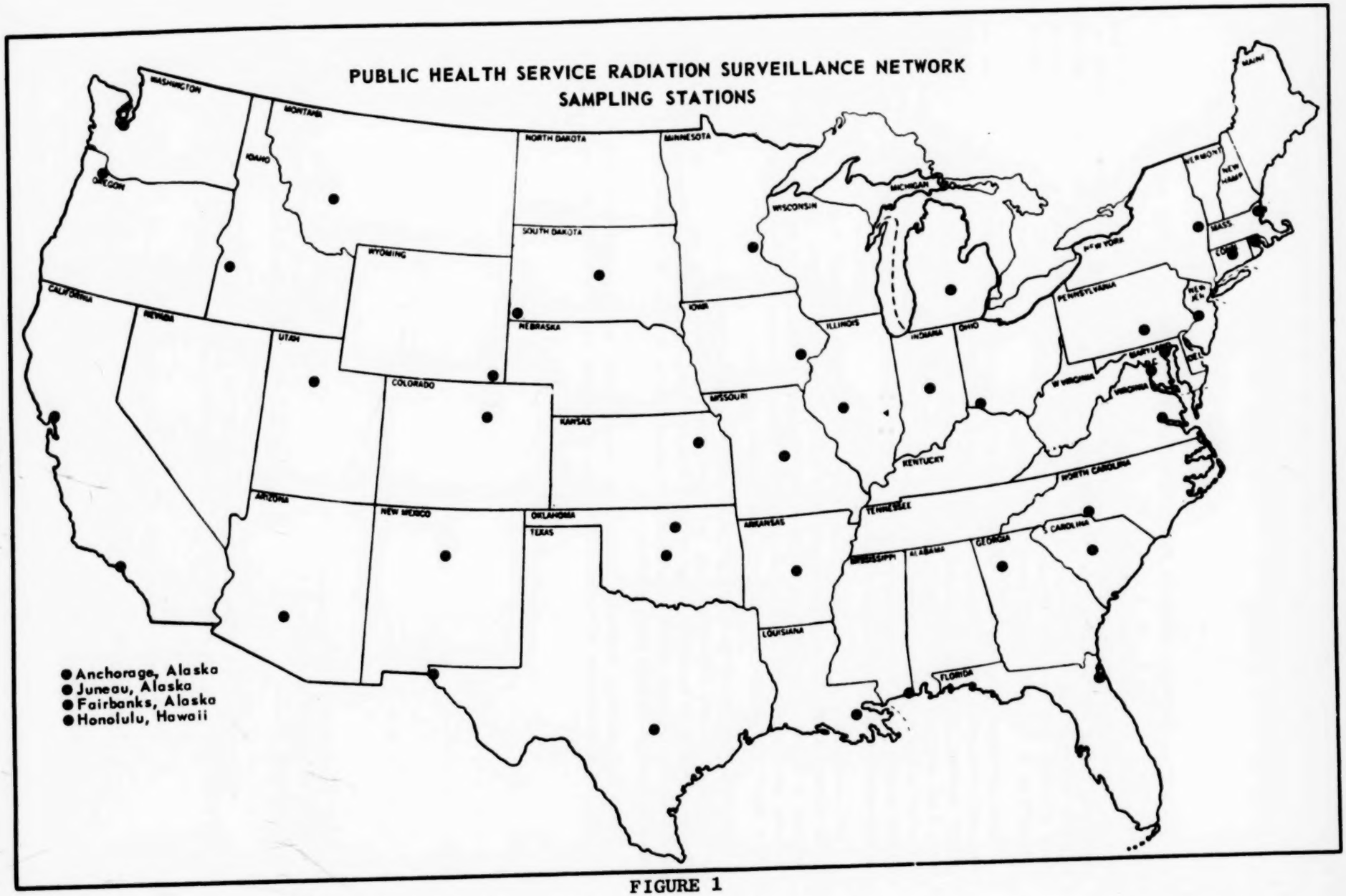

PUBLIC HEALTH SERVICE RADIATION SURVEILLANCE NETWORK
SAMPLING STATIONS
WASHINGTON
OREGON
CALIFORNIA
IDAHO
NEVADA
MONTANA
WYOMING
UTAH
ARIZONA
COLORADO
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
ILLINOIS
MICHIGAN
INDIANA
OHIO
KENTUCKY
TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
S CAROLINA
NORTH CAROLINA
W VIRGINIA
VIRGINIA
PENNSYLVANIA
NEW YORK
VERMONT
NEW HAMP
MAINE
MASS
CONN
MD
DEL
Anchorage, Alaska
Juneau, Alaska
Fairbanks, Alaska
Honolulu, Hawaii

FIGURE 1

TABLE 1.—RADIOACTIVITY OF PARTICULATES IN AIR-GROSS BETA COUNTS

Public Health Service Radiation Surveillance Network

September 1960

Station location	Weighted average ($\mu\mu c/m^3$)	Maximum ($\mu\mu c/m^3$)	Minimum ($\mu\mu c/m^3$)
Alaska, Anchorage	<0.10	<0.10	<0.10
Alaska, Fairbanks	<0.10	<0.10	<0.10
Alaska, Juneau	<0.10	<0.10	<0.10
Arizona, Phoenix	<0.10	<0.10	<0.10
Arkansas, Little Rock	<0.10	0.11	<0.10
California, Berkeley	<0.10	0.12	<0.10
California, Los Angeles	<0.10	0.13	<0.10
Colorado, Denver	<0.12	0.17	<0.10
Connecticut, Hartford	<0.10	0.14	<0.10
District of Columbia	<0.11	0.28	<0.10
Florida, Jacksonville	<0.10	0.12	<0.10
Georgia, Atlanta	<0.11	0.32	<0.10
Hawaii, Honolulu	<0.10	<0.10	<0.10
Idaho, Boise	<0.11	0.13	<0.10
Illinois, Springfield	<0.10	0.12	<0.10
Indiana, Indianapolis	<0.10	0.20	<0.10
Iowa, Iowa City	<0.11	0.12	<0.10
Kansas, Topeka	<0.11	0.14	<0.10
Louisiana, New Orleans	<0.10	<0.10	<0.10
Maryland, Baltimore	<0.12	0.18	<0.10
Massachusetts, Lawrence	<0.10	<0.10	<0.10
Michigan, Lansing	<0.10	0.22	<0.10
Minnesota, Minneapolis	<0.10	0.12	<0.10
Mississippi, Pascagoula	<0.12	0.23	<0.10
Missouri, Jefferson City	<0.11	0.15	<0.10
Montana, Helena	<0.10	<0.10	<0.10
New Jersey, Trenton	<0.12	0.14	<0.10
New Mexico, Santa Fe	<0.10	0.11	<0.10
New York, Albany	<0.10	0.13	<0.10
North Carolina, Gastonia	<0.12	0.20	<0.10
Oklahoma, Oklahoma City	<0.10	0.11	<0.10
Oklahoma, Ponca City	<0.10	<0.10	<0.10
Oregon, Portland	<0.11	0.17	<0.10
Pennsylvania, Harrisburg	<0.10	0.15	<0.10
Rhode Island, Providence	<0.11	0.16	<0.10
South Carolina, Columbia	<0.10	<0.10	<0.10
South Dakota, Edgemont	-	-	-
South Dakota, Pierre	<0.10	0.11	<0.10
Texas, Austin	<0.10	0.12	<0.10
Texas, El Paso	<0.16	0.53	<0.10
Utah, Salt Lake City	<0.10	0.14	<0.10
Virginia, Richmond	<0.10	0.12	<0.10
Washington, Seattle	<0.10	<0.10	<0.10
Wyoming, Cheyenne	<0.10	<0.10	<0.10

TABLE 2.--RADON AND THORON MEASUREMENTS

Public Health Service Radiation Surveillance Network
Station at Cincinnati, Ohio

September 1960

Date	Continuous sample collection			Radon[a] AM ($\mu\mu c/m^3$)	Radon[b] PM ($\mu\mu c/m^3$)	Thoron[c] ($\mu\mu c/m^3$)	Beta[d] activity ($\mu\mu c/m^3$)
	Sample change time	Sampling period (hours)	Volume (m^3)				
1	0830	24.3	29.7	945	178	6.3	2.3
2	0815	23.7	28.9	997	242	8.5	0.1
6	0815	95.9	115.7	423	155	7.0	0.2 (4)
7	0810	23.8	28.1	1336	241	10.9	5.3
8	0815	24.0	29.9	891	317	8.2	3.0
9	0805	23.8	29.3	302	186	5.2	0.3
12	0815	72.1	88.3	874	170	8.1	1.1 (3)
13	0815	23.9	29.3	263	72	3.1	1.1
14	0815	23.9	29.4	1102	174	8.8	3.4
15	0810	23.8	30.0	643	182	6.6	2.8
16	0810	23.9	28.8	1207	196	10.1	0.3
19	0810	71.9	88.4	345	215	4.7	0.7 (3)
20	0810	23.9	29.4	495	131	2.1	0.9
21	0830	24.3	29.5	628	209	2.9	1.0
22	0915	24.7	30.5	(e)	309	5.5	2.1
23	0810	22.8	28.3	1139	258	8.1	0.3
26	0810	71.9	88.0	1176	149	11.1	1.5 (3)
27	0820	24.1	29.5	1178	501	9.9	3.2
28	0810	23.8	29.1	457	335	5.8	2.1
29	0815	24.0	29.1	1034	231	8.3	3.0
30	0820	24.0	29.2	1289	434	13.9	0.4
	Average.....			786	232	7.8	1.7

(a) Measured within a few minutes of removal of filter from sampler and extrapolated back to collection time (uncorrected for thoron daughter interference).

(b) Filters are temporarily withdrawn from sampler at about 3 PM and counted. (Values are corrected back to removal time.) The filters are then replaced on sampler to complete the sampling period of about 24 hours.

(c) Thoron from alpha activity of filter sample counted 7 hours after taking a 24-96 hour sample.

(d) Gross beta activity when counted one day after end of sampling or later as indicated by numeral in parentheses. This activity is due principally to thoron except when counted after 3 or more days.

(e) Counter out of order.

U. S. NAVAL RESEARCH LABORATORY RADIOACTIVITY MEASUREMENTS

Radioactivity measurements of air-filter samples collected at various sites along the 80th Meridian (West) are made by the U. S. Naval Research Laboratory under a program partially financed by the Atomic Energy Commission.

The daily record of fission product beta activity during June 1960 is shown in table 1, while the radioactivity profile for the same month is shown in figure 1. All radioactivity concentrations are given in disintegrations per minute per cubic meter of air at the collecting site (2.2 disintegrations per minute per cubic meter equals 1 micromicrocurie per cubic meter).

TABLE 1.--DAILY RECORD OF FISSION PRODUCT β-ACTIVITY COLLECTED BY AIR FILTRATION

U. S. Naval Research Laboratory

September 1960

(Disintegrations/minute per cubic meter)

Day	Punta Arenas, Chile	Puerto Montt, Chile	Santiago, Chile	Antofagasta, Chile	Chacaltaya, Bolivia	Lima, Peru	Guayaquil, Ecuador
1	-	0.05	0.17	0.10	0.06	0.03	0.03
2	-	0.05	0.17	0.10	0.06	0.03	0.03
3	-	0.07	0.12	0.09	0.08	0.04	0.03
4	-	0.07	0.12	0.09	0.08	0.04	0.03
5	-	0.07	0.12	0.09	0.08	0.04	0.03
6	-	0.06	0.09	0.12	0.13	0.02	0.04
7	-	0.06	0.09	0.12	0.05	0.02	0.04
8	-	0.09	0.16	0.11	0.05	0.06	0.04
9	-	0.09	0.16	0.11	0.05	0.06	0.04
10	-	0.01	0.09	0.11	0.07	0.05	0.06
11	-	0.01	0.09	0.11	0.07	0.05	0.06
12	-	0.01	0.09	0.11	0.07	0.05	0.08
13	-	0.04	0.11	0.12	0.06	0.11	0.06
14	-	0.04	0.11	0.12	0.06	0.11	0.08
15	-	0.13	0.15	0.14	0.04	0.06	0.03
16	-	0.13	0.15	0.14	0.04	0.06	0.03
17	-	0.09	0.12	-	0.03	0.10	0.03
18	-	0.09	0.12	-	0.03	0.10	0.05
19	-	0.09	0.12	-	0.03	0.10	0.06
20	-	0.04	0.11	0.27	0.03	0.04	0.05
21	-	0.04	0.11	0.27	0.03	0.04	0.05
22	-	0.04	0.09	0.10	0.03	0.05	0.05
23	-	0.04	0.09	0.10	0.03	0.05	0.05
24	-	0.02	0.10	0.14	0.03	Tr	0.03
25	-	0.02	0.10	0.14	0.03	Tr	0.03
26	-	0.02	0.10	0.14	0.03	Tr	0.05
27	-	0.02	0.13	0.15	0.03	0.08	0.04
28	-	0.02	0.13	0.15	0.03	0.08	0.03
29	-	0.06	0.11	0.15	0.04	0.17	0.02
30	-	0.06	0.11	0.15	0.04	0.17	0.02
Mean value	-	0.05	0.12	0.13	0.05	0.06	0.04

Tr= Trace.

TABLE 1.--DAILY RECORD OF FISSION PRODUCT β-ACTIVITY COLLECTED BY AIR FILTRATION--Con.

U.S. Naval Research Laboratory

September 1960

(Disintegrations/minute per cubic meter)

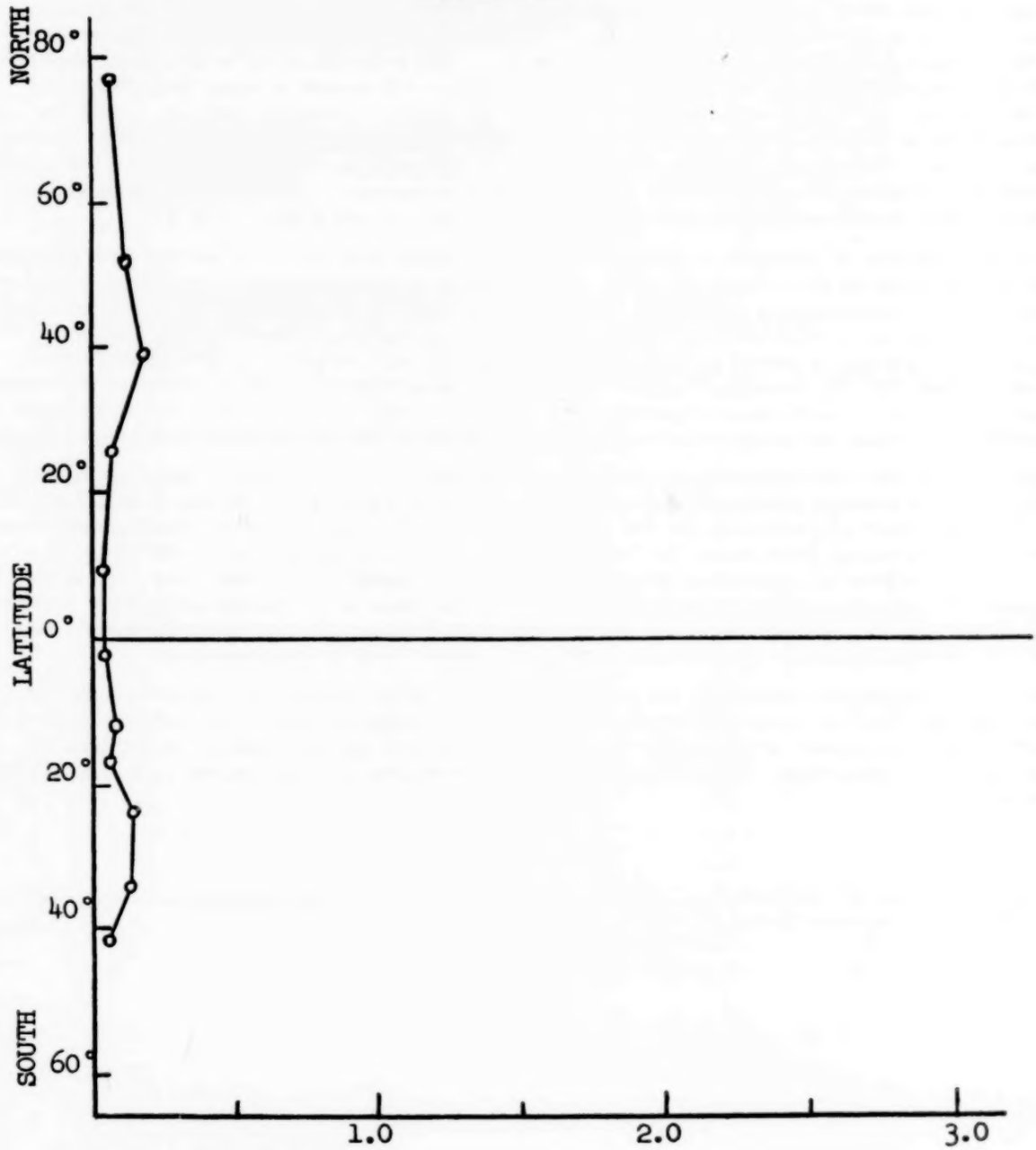
Day	Miraflores, Panama Canal	Mauna Loa, Hawaii	Miami, Florida	Washington, D. C.	Moosonee, Ontario, Canada	Thule Greenland	Bravo Arctic Ice Floe
1	0.01	0.12	-	0.11	0.16	0.08	0.02
2	0.01	0.12	0.15	0.23	0.16	0.08	0.02
3	0.02	0.10	0.08	0.23	0.06	0.08	0.02
4	0.02	0.10	0.08	0.23	0.06	0.10	0.02
5	0.02	0.10	0.08	0.23	0.06	0.10	0.02
6	0.02	0.11	0.05	0.30	0.22	0.05	0.07
7	0.02	0.11	0.05	0.30	0.22	0.05	0.07
8	0.03	0.09	0.08	0.30	0.12	0.04	0.07
9	0.03	0.09	0.08	0.30	0.12	0.04	0.07
10	0.02	0.07	0.07	0.16	0.12	0.07	0.07
11	0.02	0.07	0.07	0.16	0.11	0.07	0.07
12	0.02	0.07	0.07	0.16	0.11	0.07	0.07
13	0.05	0.13	0.08	0.16	0.14	0.05	0.02
14	0.05	0.13	0.08	0.16	0.14	0.05	0.02
15	0.04	0.12	0.08	0.24	0.05	0.06	0.02
16	0.04	0.12	0.08	0.24	0.05	0.06	0.02
17	0.03	0.09	0.06	0.20	0.12	0.03	0.02
18	0.03	0.09	0.06	0.20	0.12	0.03	0.02
19	0.03	0.09	0.06	0.20	0.12	0.03	0.02
20	0.02	0.07	0.06	0.08	0.14	0.04	0.02
21	0.02	0.07	0.06	0.08	0.14	0.04	0.02
22	0.03	0.25	0.03	0.08	0.09	0.03	0.02
23	0.03	0.25	0.03	0.08	0.09	0.03	0.02
24	0.03	0.08	0.03	0.14	0.14	0.13	0.02
25	0.03	0.08	0.03	0.14	0.14	0.13	0.02
26	0.03	0.08	0.03	0.14	0.14	0.13	0.02
27	0.02	0.06	0.07	0.12	0.10	0.09	0.02
28	0.02	0.06	0.07	0.12	0.10	0.09	0.02
29	0.03	0.03	0.12	0.14	0.11	0.06	0.02
30	0.03	0.03	0.12	0.14	0.11	0.06	0.02
Mean value	0.03	0.10	0.07	0.18	0.12	0.07	0.03

PROFILE OF BETA-ACTIVITY

AVERAGE MEASUREMENTS OF SURFACE AIR AT STATIONS ALONG THE 80TH MERIDIAN (WEST)

U. S. Naval Research Laboratory

September 1960



Average Fission Product Beta-Activity (dpm/m^3)

Figure 1

SECTION II.—FOOD, OTHER THAN MILK

THE ANNUAL AND GEOGRAPHICAL INFLUENCES ON THE STRONTIUM-90 INTAKE IN JAPANESE DIET

The Nutrition Division of the Ministry of Public Health in Japan has obtained an index on average amount of each food consumed through quarterly random sampling surveys of families in 180 districts. The strontium-90 concentration determined on each food is multiplied by the measured food intake, and these values summed to yield the value of average daily intake of strontium-90 in the Japanese diet. These values for four cities in Japan are shown in figure 1. The inherent error in this method is admittedly the fact that there can be a large variation in strontium-90 content of each food, dependent upon such factors as : (a) type of contamination; (b) location where vegetables, cereals, fruits, etc. are grown; (c) condition of medium where grown; (d) method of preparation for cooking and (e) processing and refining of foods. To arrive at an average value of Sr^{90} for each food, many assays of each food would be required. Hence, this procedure is expensive and cumbersome. Despite these difficulties, this method was used in arriving at the data represented in figure 1 and tables 1 and 2.

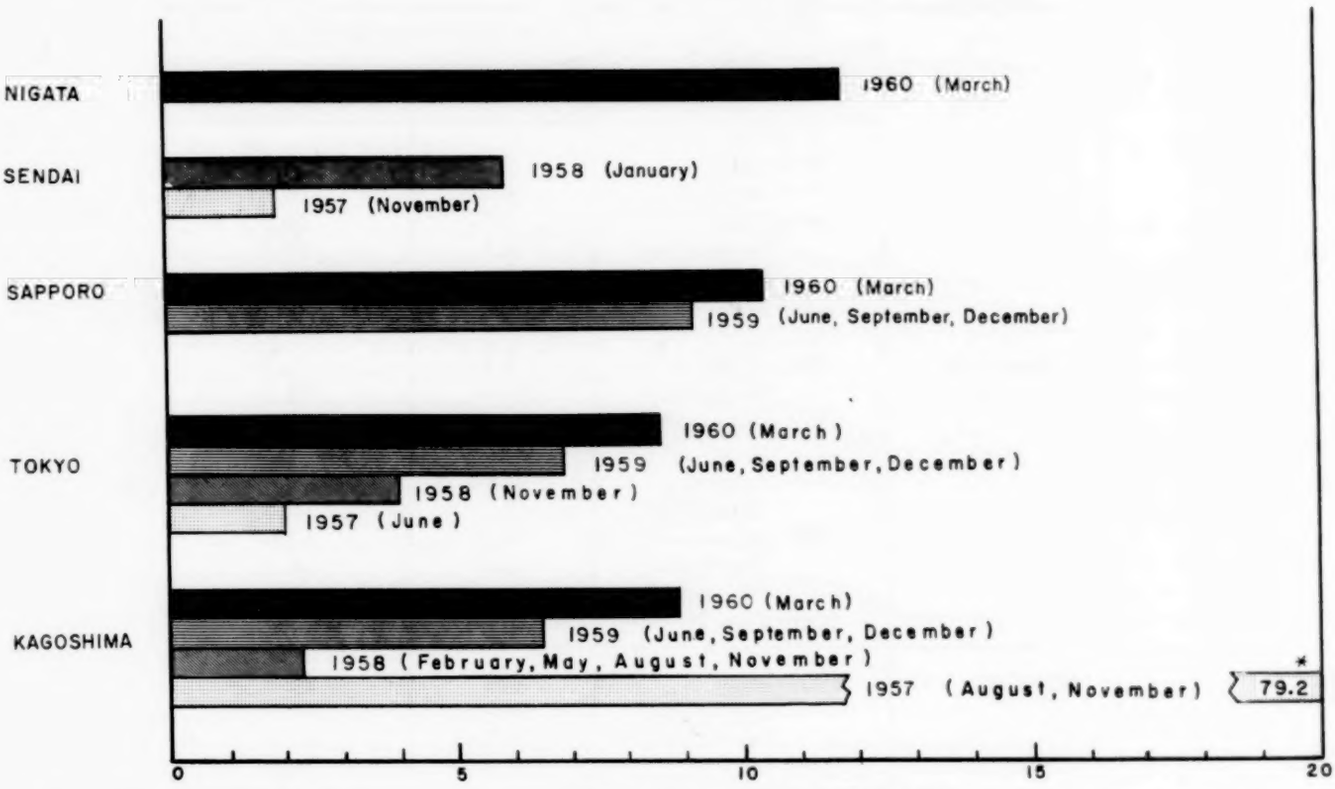
The National Institute of Nutrition in Japan has used a different system for collecting food samples to arrive at a subsequent assay of foods for daily dietary intake of strontium-90. The Institute used a "standard recipe" or recommended intakes of foods as a basis for collection and radiological assay of foods. It is of interest for comparative purposes to note the discrepancies between daily intakes of classes of foods determined by actual survey (method A) and that by "standard recipe" (method B), table 3. It is obvious that the "standard recipe" reflects the viewpoints of nutritionists as to increased intake of food classes which contribute important nutrients in the diet. For example, the differences in intake of meats, milk, eggs and leafy green vegetables are quite indicative (columns A and B in table 3).

Although the monthly measurements for Sr^{90} on the Japanese diet for the five respective cities shown in figure 1 are perhaps not extensive enough to arrive at a meaningful average, it would appear that Sendai had the lowest concentration for the period 1957 and 1958 and Nigata had the highest value in 1960. Intermediate values were shown for Tokyo, Sapporo and Kagoshima. Dr. Yoshi Hiyama, University of Tokyo, offers no explanation for the high value at Kagoshima for November 1957 other than to suggest a high concentration of particulate fallout on the food crops, particularly leafy vegetables. When comparing the Japanese values to those in the United States dietary (approximately 15 to 20 $\mu\mu c$ Sr^{90}/day) the Japanese diet would seem to present a lower level of contamination.

In table 1, Dr. Hiyama has presented the correlation coefficients between cumulative ground deposit, fallout rate and level of strontium-90 contamination in the Japanese diet. The correlation between cumulative ground deposit of strontium-90 (mc/km^2) and daily dietary intake of strontium-90 ($\mu\mu c$ and $\mu\mu c$/gm Ca) is quite high. There is no significant correlation between fallout rate and dietary intake of strontium-90.

Data from report by Dr. Yoshio Hiyama (University of Tokyo) "Annual and Geographical Change of Sr^{90} Dietary Intake of Japanese During 1957-1960--August 1960."

STRONTIUM-90 CONCENTRATION IN JAPANESE DIET OF FIVE SELECTED CITIES DURING 1957, 1958, 1959 and 1960



*Average of low value for August and a high value of 158 μμc for November 1957.

Figure 1

TABLE 1.--STRONTIUM-90 CONCENTRATION IN JAPANESE DIET

(Reference table for Figure 1.)

Location	Date	Daily per capita intake Sr^{90}	
		μμc	μμc/gm Ca
Tokyo	1957-June	2.03	3.6
	1958-November	4.07	6.8
	1959-June	7.7	10.9
	September	8.3	13.7
	December	7.5	14.4
	1960-March	8.5	21.9
Kagoshima	1957-August	0.5	0.74
	November	158.0	153.0
	1958-February	2.33	2.82
	May	0.60	1.00
	August	0.48	0.84
	November	5.7	8.5
	1959-June	6.8	12.0
	September	6.9	11.1
	December	5.8	12.1
	1960-March	7.7	20.1
Sapporo	1959-June	8.2	14.5
	September	9.3	14.9
	December	9.7	17.4
	1960-March	10.2	14.6
Nigata	1960-March	11.7	25.1
Sendai	1957-November	1.72	4.06
	1958-January	5.59	5.3
1957-59 average for country.....		6.2	11.2
1959 average for country.....		7.8	13.4

TABLE 2.—CORRELATION COEFFICIENTS BETWEEN FALLOUT, CUMULATIVE GROUND DEPOSIT AND STRONTIUM-90 CONTENT OF JAPANESE DIET

Strontium-90 content	Cumulative ground deposit (mc/km^2)	
	June 1960	July 1960
Daily intake (μμc Sr^{90})...	0.97	0.98
μμc Sr^{90}/gm Ca.....	0.91	0.90

Strontium-90 content	Fallout rate (mc/km^2/month)				
	1959		1960		
	August	August-September	May	June	July
Daily intake (μμc Sr^{90})...	0.16	- 0.90	- 0.41	0.04	- 0.07
μμc Sr^{90}/gm Ca.....	- 0.09	- 0.84	0.01	-0.24	- 0.31

TABLE 3.—COMPARISON IN DAILY FOOD INTAKES IN JAPAN BY SURVEY METHOD AND BY STANDARD RECIPE CALCULATION

Food materials	Method A (1958)* (gms)	Method B* (gms)
Cereals	421.4	439.7
Starchy roots.....	73.0	75.9
Sugars.....	12.3	11.6
Fats.....	5.7	8.6
Beans	71.0	53.75
Fish-Shellfish.....	74.9	83.0
Meats.....	17.6	44.7
Eggs	14.8	23.5
Milk.....	22.0	75.0
Vegetables, leafy green	45.8	130.0
Oranges-Tomatoes	23.0	24.0
Other vegetables	116.6	125.0
Other fruits.....	54.2	10.0
Pickled vegetables	52.7	16.6
Dried vegetables	2.3	0.23

*Method A—Survey of families in 180 districts.
Method B—Calculated from "standard recipe."

SECTION III.—MILK

PUBLIC HEALTH SERVICE MILK MONITORING PROGRAM

The original Public Health Service Milk Monitoring Program consisted of 12 sampling stations of which 9 are still active. Raw milk was spot sampled at these stations. During 1960 a new sampling program of about 60 stations was established. Processed milk was sampled at these stations. Since the sampling procedures for the raw milk sampling stations and the processed milk area sampling stations are different, they are described and reported separately. The Public Health Service Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, continues to conduct the analyses for the original network stations; the Public Health Service Southeastern Radiological Health Laboratory at Montgomery, Alabama, and the Southwestern Radiological Health Laboratory at Las Vegas, Nevada, provide this service for the new program.

The purpose of the two sampling programs is not the same. The original network was established to develop sampling and radiochemical analytical proficiencies. During the existence of this program it became apparent that a broader sampling program, more directly related to the milk consumed by the population, was necessary, and the Public Health Service and the Department of Health, Education, and Welfare moved to provide facilities for this change. This resulted in the transition from the program of sampling raw milk, collected from milksheds of limited size, to a sampling program designed to be representative of the processed milk consumed in a given municipality.

In some instances the designated points are the same as those which were reported originally. The establishment of the new processed milk area sampling stations does not preclude the need for further raw milk sampling from the selected milkshed serving the same city. It is important that both networks be in operation for a sufficient period of time to provide an overlap for the purpose of comparative study.

Because of the different sources of these samples, changes in the collecting system, and the utilization of different laboratory techniques, differences were anticipated in the amounts of radioactivity found in the milk under the two programs. For this reason, an investigation to determine the comparability of the two programs was begun in January 1961. This investigation covers all possible factors including both the laboratory methodology and collecting methods. Until this study has been completed, and additional experience has been gained under the new program, no valid interpretation can be made of any differences of radioactivity in milk samples collected under the two systems.

Publication of the data will normally follow about four months after collection of samples because of the time required for shipment, processing, decay product build-up, compilation of the data, clearance and publication procedures.

Raw Milk Sampling Stations

The initial purpose of establishing this network was in keeping with the normal and continuing program of the Public Health Service to determine trends in our changing environment, including measurement of amounts of radioactivity in water, air, milk and other foods. Milk was the food chosen for initial testing because it is among the most important components of the diet and is available at all seasons of the year and in all climates. A primary objective of the project was to develop effective collection systems and radiochemical analysis procedures to make them more suitable for larger scale programs.

The criteria on which the selection of the original sampling stations were based appeared in the discussion sections of all Volume I issues of Radiological Health Data.

One-gallon raw milk samples are collected once each month and forwarded by air parcel post to the Robert A. Taft Sanitary Engineering Center for radionuclide analysis. It is estimated that these samples represent 2,000-gallon lots. The concentration of iodine-131, barium-140, cesium-137 and naturally-occurring potassium-40 are all currently being measured, when present in the milk, by gamma scintillation spectroscopy. Total radiostrontium and strontium-90 are determined following radiochemical separations, the strontium-90 being calculated by measuring the build-up in a two-week period of the daughter decay product, yttrium-90, using a low background anticoincidence beta counter. The total radioactive strontium is counted in a shielded internal proportional counter with the strontium-89 calulated as the difference.

April through September 1960 issues of Radiological Health Data list references for technical descriptions of the methodology of analyses used.

October data for the raw milk sampling stations are presented in table 1.

Processed Milk Area Sampling Stations

The monitoring of milk has been expanded to provide additional information on levels of radioactivity in milk consumed by the public. The new stations have been established in cooperation with State and local health and milk sanitation agencies. The cities have been selected in order to provide adequate coverage from the combined viewpoints of production areas and consuming population. The emphases on this expanded sampling and radioassay program are:

1. Measuring the radioactivity levels of the milk consumed by the public in various regions of the country by obtaining samples of pasteurized and homogenized milk at the processing plant, and
2. Providing one sampling point within each State with additional points when indicated by widely varying conditions of the milk supply or the need to provide coverage of large population groups. This differs from the original set of sampling stations whose selection was based principally upon certain criteria involving the milk production and milkshed area characteristics.

The new network was designed to sample processed milk rather than the raw product. The sampling procedure was developed to provide a sample from one day's sales per month in a community which will be as representative of the total supply as can be achieved under practical conditions. The sample will be a composite of those plants supplying not less than 90% of the city's milk supply. The contribution from each plant to the total sample will be approximately proportional to volume of milk sold.

The samples from the new stations are collected with the assistance of the various State and local health and milk sanitation agencies and are shipped for analysis to either the Southwestern or Southeastern Radiological Health Laboratory. The Southeastern Radiological Health Laboratory processes samples from the 30 states generally east of the Mississippi, and the Southwestern Radiological Health Laboratory processes samples from the western states.

At the present time radioassays for Sr^{89}, Sr^{90} and Cs^{137} are being performed. Other radionuclides of concern to public health agencies will be included for assay as necessary for complete monitoring of the milk supply.

Data from the two laboratories are presented in table 2.

TABLE 1.--RADIOACTIVITY IN MILK

Public Health Service Milk Monitoring Program
Robert A. Taft Sanitary Engineering Center
Raw Milk Sampling Stations

September 1960

(Radioactivity in μμc/liter)

Area	Calcium (grams/liter)		Iodine-131		Strontium-89		Strontium-90		Barium-140		Cesium-137	
	Sept.	Yearly average	Sept.	Yearly average	Sept.	Yearly average	Sept.	Yearly average	Sept.	Yearly average	Sept.	Yearly average
Atlanta, Ga.	1.11	1.12	ND	<10	ND	<5	14	15	ND	<10	20	43
Austin, Texas	1.10	1.09	ND	<10	ND	<5	3	5	ND	<10	10	19
Chicago, Illinois	1.12	1.09	ND	<10	ND	<5	7	10	ND	<10	20	34
Cincinnati, Ohio	1.05	1.11	ND	<10	ND	<5	8	11	ND	<10	10	27
New York, New York	1.08	1.07	ND	<10	ND	<5	8	10	ND	<10	10	30
Sacramento, Calif.	1.15	1.10	ND	<10	ND	<5	4	4	ND	<10	5	10
Salt Lake City, Utah	1.05	1.09	ND	<10	ND	<5	5	7	ND	<10	15	33
Spokane, Washington	1.13	1.10	ND	<10	ND	<5	8	12	ND	<10	25	47
St. Louis, Missouri	1.10	1.21	ND	<10	ND	<5	15	20	ND	<10	20	35

Samples are taken at one sampling point from the milk supply of the areas listed above.
ND--No detectable activity

TABLE 2.—RADIOACTIVITY IN MILK

Public Health Service Milk Monitoring Program

Processed Milk Area Sampling Stations—September 1960

(Radioactivity in μμc/liter)

Area	Calcium (grams/liter)		Strontium-89		Strontium-90		Cesium-137	
	Sept.	Average to date	Sept.	Average to date	Sept.	Average to date	Sept.	Average to date
Albuquerque, N. Mex.	1.01	1.16	ND	<5	4	4	-	-
Atlanta, Ga.	1.27	1.24	ND	<5	11	11	<10	<10
Austin, Tex.	1.16	1.13	ND	<5	3	2	<10	<10
Baltimore, Md.	1.18	1.08	ND	<5	7	6	<10	<10
Boston, Mass.	1.20	1.17	ND	<5	8	13	<10	20
Buffalo, N. Y.	1.14	1.19	ND	<5	6	7	<10	<10
Burlington, Vt.	1.30	1.19	ND	<5	7	9	<10	10
Charleston, S. C.	1.24	1.22	ND	<5	10	10	<10	10
Charleston, W. Va.	1.14	1.16	ND	<5	8	9	<10	<10
Charlotte, N. C.	1.24	1.19	ND	<5	14	12	<10	10
Chattanooga, Tenn.	1.27	1.27	ND	<5	11	11	<10	<10
Chicago, Ill.	1.16	1.09	ND	<5	6	7	<10	<10
Cincinnati, Ohio	1.16	1.15	ND	<5	8	8	<10	<10
Cleveland, Ohio	1.16	1.09	ND	<5	8	8	<10	<10
Dallas, Tex.	1.23	1.23	ND	<5	6	6	<10	<10
Denver, Colo.	1.02	1.11	ND	<5	6	7	-	-
Des Moines, Iowa	0.94	1.03	ND	<5	7	7	-	20
Detroit, Mich.	1.20	1.13	ND	<5	8	7	<10	<10
Grand Rapids, Mich.	1.22	1.20	ND	<5	7	8	<10	<10
Hartford, Conn.	1.14	1.15	ND	<5	9	9	<10	15
Helena, Mont.	1.06	1.08	ND	<5	8	6	-	25
Honolulu, Hawaii	1.06	1.08	ND	<5	7	5	-	40
Idaho Falls, Idaho	1.03	1.05	ND	<5	6	5	-	40
Indianapolis, Ind.	1.19	1.16	ND	<5	6	6	<10	<10
Jackson, Miss.	1.26	1.24	ND	<5	10	12	<10	<10
Kansas City, Mo.	1.01	1.08	ND	<5	10	8	-	-
Laramie, Wyo.	0.98	1.07	ND	<5	5	5	-	-
Las Vegas, Nev.	0.90	1.05	ND	<5	2	2	-	-
Little Rock, Ark.	1.20	1.20	ND	<5	16	13	<10	<10
Louisville, Ky.	1.14	1.17	ND	<5	9	8	<10	<10
Manchester, N. H.	1.22	1.22	ND	<5	10	12	<10	35
Memphis, Tenn.	1.22	1.22	ND	<5	14	14	<10	<10
Milwaukee, Wis.	1.20	1.15	ND	<5	5	6	<10	<10
Minneapolis, Minn.	1.04	1.00	ND	<5	8	9	-	-
New Orleans, La.	1.33	1.23	ND	<5	16	16	<10	<10
New York, N. Y.	1.12	1.10	ND	<5	8	10	<10	10
Norfolk, Va.	1.22	1.17	ND	<5	8	9	<10	<10
Oklahoma City, Okla.	1.18	1.15	ND	<5	9	8	<10	<10
Omaha, Nebr.	0.98	1.02	ND	<5	6	8	-	-
Palmer, Alaska	0.97	1.06	ND	<5	9	7	-	-
Philadelphia, Pa.	1.16	1.14	ND	<5	7	9	<10	10
Phoenix, Ariz.	0.98	0.99	ND	<5	3	4	-	-
Pittsburgh, Pa.	1.16	1.21	ND	<5	8	13	<10	10
Portland, Maine	1.15	1.13	ND	<5	8	12	<10	25
Portland, Oreg.	1.10	1.09	ND	<5	8	10	-	-
Providence, R. I.	1.15	1.15	ND	<5	9	13	<10	15
Sacramento, Calif.	1.05	1.04	ND	<5	6	5	-	-
Salt Lake City, Utah	1.08	1.10	ND	<5	6	6	-	-
San Francisco, Calif.	1.04	1.08	ND	<5	2	4	-	-

See footnotes at end of table.

TABLE 2.--RADIOACTIVITY IN MILK--Con.

Public Health Service Milk Monitoring Program

Processed Milk Area Sampling Stations--September 1960

(Radioactivity in uuc/liter)

Area	Calcium (grams/liter)		Strontium-89		Strontium-90		Cesium-137	
	Sept.	Average to date	Sept.	Average to date	Sept.	Average to date	Sept.	Average to date
San Juan, P. R.	1.16	1.12	ND	< 5	4	4	< 10	< 10
Seattle, Wash.	1.06	1.08	ND	< 5	9	9	-	60
Spokane, Wash.	0.96	1.06	ND	< 5	7	8	-	-
St. George, Utah	1.00	0.98	ND	< 5	6	5	-	-
St. Louis, Mo.	1.06	1.02	ND	< 5	7	6	-	-
Syracuse, N. Y.	1.17	1.22	ND	< 5	6	7	< 10	10
Tampa, Fla.	1.26	1.24	ND	< 5	5	4	86	80
Trenton, N. J.	1.11	1.15	ND	< 5	7	8	< 10	< 10
Washington, D. C.	1.18	1.13	ND	< 5	6	8	< 10	< 10
Wichita, Kans.	1.08	1.08	ND	< 5	6	6	-	-
Wilmington Del.	1.17	1.20	ND	< 5	8	9	< 10	15

ND--No detectable activity.

Because this program was initiated in 1960 and sampling stations necessarily became operative in a staggered sequence, the averages shown represent all samples taken to date. Averages will normally be for the latest 12 month period after sampling began. For the September data, the average covers a period of one to seven months.

SECTION IV.—WATER

PUBLIC HEALTH SERVICE NATIONAL WATER QUALITY NETWORK

The National Water Quality Network was established under the provision of Section 4 (c) of Public Law 660, which states"... the Surgeon General shall... collect and disseminate basic data... (relating) to water pollution and the prevention and control thereof."

This Network, operated in cooperation with State and local health agencies, was started in October 1957. At present there are 75 sampling stations located on major waterways used for public water supply, propagation of fish and wildlife, recreational purposes, and for agricultural, industrial and other uses; some of these stations are interstate, coastal, and International Boundary waters, and waters on which activities of the Federal Government may have an impact. Ultimately a total of 250 to 300 stations will be operated. A few of the more recently established stations have not begun to report radioactivity.

Samples of water are examined for chemical, physical, and biological quality insofar as these relate to pollution. Samples for some determinations are taken weekly, others monthly, and for some continuous composite samples of 10 to 15 days are obtained.

Gross alpha and beta measurements are made on both suspended and dissolved solids in the raw surface water samples. The radioactivity levels of dissolved solids provide a rough measure of the levels which may be found in a treated water, where such water treatment removes substantially all of the suspended matter. Naturally occurring radioactive substances in the environment are the source of essentially all of the alpha activity. The contamination of the environment from man-made sources is the major contributor to the beta activity. It should be noted that with the cessation of weapons testing, beta activity in most raw waters is generally approaching a level attributable solely to natural beta activity. Natural beta activity can be two or three times the natural alpha activity based on the same nuclides being present. Some exceptions to this are seen, notably the data for the Columbia River and the Animas River. The results are reported in micromicrocuries per liter, and are shown for each station on a given river.

While beta determinations for the first two years of the Network operation have been done on each sample weekly, the alpha determinations are reported generally on a composite sample of more than one week. Beginning with samples taken in January 1960, beta determinations were performed on composite samples obtained by combining two weekly samples. The alpha data will be reported on three-month composite samples, with 1/3 of the stations being covered each month. All the data reported below represent the average of all information available for the month indicated.

Strontium-90 data are reported as being the results of determinations on composite samples for a three-month period ending in the month shown.

Additional information and data may be obtained from the following sources:

1. "National Water Quality Network Annual Compilation of Data," PHS Publication. For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price $1.50.

2. "Report on National Water Quality Control Network," submitted by Dr. F. J. Weber, Chief, Division of Radiological Health, PHS, to Joint Committee on Atomic Energy Hearings on Fallout from Nuclear Weapons Tests, Vol. 1, May 1959, pages 167-169.

PUBLIC HEALTH SERVICE NATIONAL WATER QUALITY NETWORK
SAMPLING STATIONS

As of June 30, 1960

FIGURE 1

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS

Public Health Service National Water Quality Network

(Micromicrocuries per liter)

Station	Quarter ending June 30, 1960	August 1960					
	Strontium-90	Beta activity			Alpha activity		
		Susp.	Diss.	Total	Susp.	Diss.	Total
ANIMAS RIVER							
Cedar Hill, N. Mex.	0.3	14	20	34	6	18	24
APALACHICOLA RIVER							
Chattahoochie, Fla.	(*)	0	0	0	0	0	0
ARKANSAS RIVER							
Coolidge, Kans.	1.1	0	0	0	0	26	26
Ponca City, Okla.	1.3	54	2	56	48	4	52
Fort Smith, Ark.	1.1	15	3	18	2	1	3
Pendleton Ferry, Ark.	1.2	14	9	23	14	0	14
CHATTAHOOCHIE RIVER							
Atlanta, Ga.	(*)	0	0	0	1	0	1
Columbus, Ga.	0.5	0	1	1	0	0	0
COLORADO RIVER							
Loma, Colo.	0.3	0	6	6	2	12	14
Page, Ariz.	0.9	69	1	70	26	14	40
Hoover Dam, Ariz.-Nev.	1.3	0	1	1	0	11	11
Parker Dam, Ariz.-Calif.	0.4	-	-	-	-	-	-
Yuma, Ariz.	1.0	0	8	8	<1	16	16
COLUMBIA RIVER							
Pasco, Wash.	0.3	27	276	303	0	0	0
Wenatchee, Wash.	0.3	0	0	0	-	-	-
Bonneville Dam, Oreg.	(*)	16	186	202	-	-	-
Clatskanie, Oreg.	0.3	-	-	-	-	-	-
CONNECTICUT RIVER							
Northfield, Mass.	(*)	1	0	1	-	-	-
DELAWARE RIVER							
Martin's Creek, Pa.	0.4	0	0	0	0	1	1
Philadelphia, Pa.	0.3	0	6	6	3	1	4
GREAT LAKES							
Gary, Ind.	(*)	0	0	0	0	0	0
Duluth, Minn.	0.3	0	0	0	0	0	0
Detroit, Mich.	0.6	<1	0	<1	0	0	0
Buffalo, N. Y.	0.7	4	4	8	1	1	2
Milwaukee, Wis.	-	0	0	0	0	2	2
HUDSON RIVER							
Poughkeepsie, N. Y.	0.7	0	4	4	0	1	1
ILLINOIS RIVER							
Peoria, Ill.	0.8	5	19	24	<1	1	2

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS—Con.

Public Health Service National Water Quality Network

(Micromicrocuries per liter)

Station	Quarter ending June 30, 1960	August 1960					
	Strontium-90	Beta activity			Alpha activity		
		Susp.	Diss.	Total	Susp.	Diss.	Total
KANAWHA RIVER							
Winfield Dam, W. Va.	0.3	0	0	0	0	1	1
MISSISSIPPI RIVER							
Red Wing, Minn.	1.5	0	5	5	1	2	3
Dubuque, Iowa	(*)	0	<1	<1	1	3	4
Burlington, Iowa	(*)	1	0	1	0	0	0
East St. Louis, Ill.	1.2	0	2	2	0	3	3
Cape Girardeau, Mo.	0.9	0	0	0	-	-	-
West Memphis, Ark.	0.9	8	10	18	-	-	-
Delta, La.	(*)	0	6	6	1	2	3
New Orleans, La.	1.0	0	0	0	-	-	-
MISSOURI RIVER							
Williston, N. Dak.	0.7	7	5	12	1	7	8
Bismarck, N. Dak.	0.9	-	-	-	-	-	-
Yankton, S. Dak.	1.0	<1	4	4	0	4	4
Omaha, Nebr.	0.6	0	10	10	8	8	16
St. Joseph, Mo.	0.9	15	5	20	5	4	9
Kansas City, Kans.	0.9	11	2	13	2	6	8
St. Louis, Mo.	1.0	0	14	14	-	-	-
OHIO RIVER							
East Liverpool, Ohio	1.9	0	3	3	0	0	0
Wheeling, W. Va.	-	<1	2	2	2	<1	2
Huntington, W. Va.	0.3	0	8	8	1	14	15
Cincinnati, Ohio	0.6	0	2	2	1	0	1
Evansville, Ind.	0.4	1	0	1	-	-	-
Cairo, Ill.	0.7	0	4	4	-	-	-
POTOMAC RIVER							
Williamsport, Md.	0.8	0	0	0	0	1	1
Great Falls, Md.	0.5	2	2	4	0	0	0
RED RIVER							
Denison, Tex.	1.2	0	0	0	1	12	13
Index, Ark.	1.2	0	1	1	1	5	6
Alexandria, La.	0.7	3	0	3	1	3	4
RIO GRANDE RIVER							
El Paso, Tex.	1.4	2	2	4	2	11	13
Laredo, Tex.	1.0	26	11	37	75	4	79
Brownsville, Tex.	0.7	0	0	0	0	8	8
SABINE RIVER							
Ruliff, Tex.	(*)	0	<1	<1	1	0	1
ST. CLAIR RIVER							
Port Huron, Mich.	(*)	0	2	2	0	<1	<1

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS—Con.

Public Health Service National Water Quality Network

(Micromicrocuries per liter)

Station	Quarter ending June 30, 1960	August 1960					
	Strontium-90	Beta activity			Alpha activity		
		Susp.	Diss.	Total	Susp.	Diss.	Total
ST. LAWRENCE RIVER							
Massena, N. Y.	0.6	0	2	2	0	<1	<1
ST. MARY'S RIVER							
Sault Ste. Marie, Mich.	0.4	6	0	6	0	0	0
SCHUYLKILL RIVER							
Philadelphia, Pa.	0.7	0	24	24	0	1	1
SAVANNAH RIVER							
North Augusta, S. C.	(*)	<1	3	4	1	0	1
Port Wentworth, Ga.	0.8	1	34	35	1	<1	2
SNAKE RIVER							
Wawawai, Wash.	0.3	0	2	2	0	4	4
Weiser, Idaho	0.5	0	7	7	-	-	-
SUSQUEHANNA RIVER							
Sayre, Pa.	0.4	0	0	0	0	0	0
Conowingo, Md.	0.2	0	2	2	0	1	1
TENNESSEE RIVER							
Chattanooga, Tenn.	1.3	0	48	48	0	<1	<1
YELLOWSTONE RIVER							
Sidney, Mont.	0.3	0	4	4	1	8	9

*Insufficient sample for analysis.

SECTION V.—OTHER DATA

EXTERNAL GAMMA ACTIVITY

PUBLIC HEALTH SERVICE RADIATION SURVEILLANCE NETWORK

Portable survey instruments are available at the stations of the Radiation Surveillance Network and one of their uses is to record external gamma radiation. These readings are not precise, especially for measurement of low levels but they can show the presence or absence of any significant increases above background. The differences among the values shown on the following table are within the variance anticipated due to differences in normal background and in instrument response characteristics.

TABLE 1.--EXTERNAL GAMMA ACTIVITY

Public Health Service Radiation Surveillance Network

September, 1960

Station location	Average* (mr/hr)	Station location	Average* (mr/hr)
Alaska, Anchorage	0.01	Mississippi, Pascagoula	(**)
Alaska, Fairbanks	0.01	Missouri, Jefferson City	0.01
Alaska, Juneau	0.01	Montana, Helena	0.03
Arizona, Phoenix	0.01	New Jersey, Trenton	0.02
Arkansas, Little Rock	0.01	New Mexico, Santa Fe	0.04
California, Berkeley	0.01	New York, Albany	0.02
California, Los Angeles	0.01	North Carolina, Gastonia	0.02
Colorado, Denver	0.02	Ohio, Cincinnati	(**)
Connecticut, Hartford	0.01	Oklahoma, Oklahoma City	0.02
District of Columbia	0.02	Oklahoma, Ponca City	0.04
Florida, Jacksonville	0.01	Oregon, Portland	0.01
Georgia, Atlanta	0.02	Pennsylvania, Harrisburg	0.01
Hawaii, Honolulu	0.03	Rhode Island, Providence	0.02
Idaho, Boise	0.02	South Carolina, Columbia	0.02
Illinois, Springfield	0.01	South Dakota, Edgemont	(**)
Indiana, Indianapolis	0.01	South Dakota, Pierre	0.02
Iowa, Iowa City	0.02	Texas, Austin	0.01
Kansas, Topeka	0.02	Texas, El Paso	0.02
Louisiana, New Orleans	0.01	Utah, Salt Lake City	0.02
Maryland, Baltimore	0.02	Virginia, Richmond	0.01
Massachusetts, Lawrence	0.02	Washington, Seattle	0.02
Michigan, Lansing	0.02	Wyoming, Cheyenne	0.02
Minnesota, Minneapolis	0.01		

* Readings taken three feet above the ground.
** No data received.

RADIOACTIVE CONTAMINATION OF JET AIRCRAFT

There are three public health aspects of radioactive contamination and radiation exposure associated with jet aircraft.

1. In-flight external exposure of passengers and crew from radioactive particles formed from weapons testing and natural radiation. Measurements indicate that the former has not resulted in any detectable radiation exposure while the latter represents cosmic ray exposure of extra-terrestial origin and is the more significant.

2. In-flight inhalation exposure from air-borne activity in the cabin. Results obtained are similar to air contamination at ground level.

3. External occupational exposure to maintenance personnel working on the aircraft while it is on the ground. During the spring of 1959 when man-made concentrations in air were considerably higher than current concentrations, the major exposure was occupational--but the data indicated this was small.

The following article by Mr. Robert H. Neill, Division of Radiological Health, Public Health Service presents some data on the contamination of jet aircraft.

RADIOACTIVE CONTAMINATION OF JET AIRCRAFT

Division of Radiological Health
Public Health Service

Radioactive contamination of jet aircraft generally results from in-flight accumulation of radioactive particles on the exterior surfaces of the aircraft. These radioactive particles, resulting from nuclear weapons testing, have various residence times in the upper atmosphere before eventually settling to earth in the form of fallout.[1] This contamination is not inherently unique to jet aircraft; it has also been measured on propeller-driven aircraft. Government agencies, including the U. S. Atomic Energy Commission,[2] U. S. Air Force[3] and the Federal Aviation Agency, have studied this question in the past. Exposures may be received from cosmic radiation and the inhalation of cabin air containing fission products and natural radioactive materials.

The atmosphere is divided into the troposphere and stratosphere separated by the tropopause, which varies in height from 50,000 feet at the equator to about 35,000 feet at the poles. That part of a nuclear cloud contained in the troposphere, or area where weather is generated, will exhibit a residence time on the order of a month. Radioactive debris carried into the upper part of the atmosphere or stratosphere will circulate and may exhibit a residence time from less than a year to several years; evidently this is dependent on the height and latitude of detonations.[4]

For aircraft operating below the tropopause, surface contamination would be witnessed only for a relatively short time after a test series. Thus the air concentration would contribute very little to surface contamination of aircraft. With travel at the higher altitudes contamination has been witnessed for a much longer period of time.

Surveys

In cooperation with the Pan-American World Airways system, the Public Health Service obtained measurements from February 1959 to April 1960 to assess radiation exposures to passengers, crew and ground maintenance personnel.

Measurements of beta-gamma radioactivity of the external surfaces of jet aircraft were recorded for a period of over a year. Pan-American routinely surveyed different aircraft on arrival at the New York International Airport. The results showed a tendency for fission product debris to adhere to those surfaces where the air undergoes an abrupt change in direction. A build-up of activity also occurs at the site of oily smears. Similar results have been noted by the British.[5] At the site of the pressurization system air inlet, where airflow undergoes an abrupt change in direction, activity levels are higher. It should be noted here that exposure levels due to external contamination, measured inside the passenger compartment and the cockpit, were similar to those experienced at ground level. Measurements taken on surfaces perpendicular to the air flow, such as the leading edge of a wing where it joins the fuselage, show low readings. This may be due to the air cushioning effect of airflow stagnation at the surface.

[1-5]See references on p. 88-89.

Measurements show that the activity does not appear to build up indefinitely but reaches a state of equilibrium. Data from measurements obtained on selected surfaces from February 1959 to November 1959 have shown levels decreasing more rapidly than would be expected by normal decay. It would seem that weathering, such as flying through rain, assists this process.

Table 1 lists average results of surveys made during the late fall of 1959 on a number of commercial jet aircraft in routing operation. Table 2 presents data on the concentration of radioactive material in the cabin air of commercial and military jet aircraft.

TABLE 1.—TYPICAL RESULTS OF JET AIRCRAFT RADIATION MONITORING

December 1959

Location	Beta and gamma				Gamma	
	mr/hr	cpm	mr/hr	cpm	cpm	cpm
Probe to surface distance	1"	1"	3"	3"	1"	3"
Exterior:						
Forward cabin outflow valve	0.3	1200	0.1	400	100	100
Electronics cooling outlet	1.6	6500	.4	1600	200	100
Center cabin outflow valve	0.6	2500	.2	800	150	100
Interior:						
Forward galley vent	0.02	75	0.20	75	50	50
Grill—aft water tank gage	.02	75	.015	50	50	50

Instrument used: Thyac 389C portable survey meter.
Beta-gamma background—150 cpm.
Gamma background—75 cpm.

TABLE 2.--CONCENTRATIONS OF RADIOACTIVE MATERIALS IN CABIN AIR

Date	From	To	Aircraft	Altitude (feet)	Sampled by	Beta activity ($\mu\mu c/m^3$)	Alpha activity ($\mu\mu c/m^3$)	Analyzed by	Period of Sampling (min)
Oct. 7, 1959	Seattle	Bermuda	Boeing 707	31,000	PHS	No detectable activity	No detectable activity	PHS Cincinnati	120 (power failure)
Dec. 8, 1959	New York	London	Boeing 707	Unknown	AEC	0.06	0.3	AEC, NYOO	Unknown
Mar. 3, 1960	Long Beach	Miami	Douglas DC-8	33,000	PHS	0.7	No det. activity	PHS Cincinnati	250
Fall 1959	Castle AFB over western U.S.		KC-135	41,000	USAF	No det. act.	No det. act.	USAF	45
Fall 1959	Castle AFB over western U.S.		KC-135	42,000	USAF	8.0	0.1	USAF	70
Fall 1959	Castle AFB over western U.S.		KC-135	44,000	USAF	2.96	$9X10^{-3}$	USAF	86
Fall 1959	Castle AFB over western U.S.		KC-135	38,000	USAF	4.87	No det. act.	USAF	90
Fall 1959	Castle AFB over western U.S.		KC-135	32,000	USAF	1.43	$1.3X10^{-2}$	USAF	120
Winter 1960	Clinton-Sherman AFB		B-52	Unknown	USAF	No det. act.	No det. act.	USAF	Unknown

Mops as a Screening Device

As a means of screening aircraft to determine any unusual increase in external contamination for maintenance personnel working in the vicinity, Pan-American World Airways recorded measurements of activity of the mops used in washing down the exteriors of the aircraft.

To ascertain the type of activity present, one mop was forwarded to the Public Health Service Sanitary Engineering Center in Cincinnati in March 1959 for detailed radioisotopic analysis.

The total activity of the mop was 3.2 microcuries gross beta with a possibility of gross alpha amounting to less than 0.002 microcuries or 0.06 percent of the gross beta.

An initial gamma spectral determination on the mop as received showed prominent activities of Zr^{95}-Nb^{95}, Ru-Rh, and Ce-Pr. The mop was then ashed and the ash divided into acid soluble and acid insoluble fractions. The distribution of gross beta activity was approximately equal in the two fractions, 57 percent being found in the soluble fraction as against 43 percent in the insoluble fraction. On the other hand about 90 percent of the strontium-90 was found in the soluble fraction and only 10 percent in the insoluble fraction. The more prominent gamma emitters (Zr-Nb, Ru-Rh, and Ce-Pr) were found in both the soluble and insoluble fractions. Tungsten-185 was found only in the insoluble fractions and zinc-65 only in the soluble fraction.

The gross activity and strontium-90 values obtained are shown in the following table.

TABLE 3.--MOP GROSS ACTIVITY AND STRONTIUM-90 CONTENT

Fraction	Gross beta (μc/mop)	Gross alpha (μc/mop)	Strontium-90 (μc/mop)
Insoluble.....	1.37	-	0.003
Soluble.....	1.83	0.002	0.034
Total.....	3.20	0.002	0.037

It is not known if in the washing process a solvent was used which would tend to distort the relative values of the soluble and insoluble fraction.

Air Filters

In order to obtain a qualitative picture of the air entering the cabin on a commercial jet carrier, millipore filters were fastened to the auxiliary cabin air inlet on a Boeing 707 in March 1959. This arrangement was not satisfactory as many of the filters tore due to the air pressure, and no way was available to determine the amount of air filtered. The filters were counted for gross beta at the Public Health Service, Division of Radiological Health Laboratory in Washington. Results ranged from background to about 3000 $\mu\mu$c per filter, with most filters averaging a few hundred $\mu\mu$c. These are shown in the following table.

TABLE 4.--RESULTS OF ANALYSES OF MILLIPORE FILTERS FASTENED TO THE CABIN AUXILIARY AIR INLETS OF COMMERCIAL JETS

Aircraft number	Date sample taken (1959)	Radioactivity (gross beta) ($\mu\mu$c)
710.....	April 1	66
711.....	April 1	126
711.....	March 28	104
711.....	March 30	177
710.....	March 30	582
711.....	May 13	450
710.....	April 16	1148
711.....	April 16	8
711.....	April 12	52
710.....	April 12	2802
711.....	April 11	540

Air-Water Separators

Eighteen air-water separators from the auxiliary air intake on commercial 707's were analyzed by gamma spectroscopy at the Sanitary Engineering Center in Cincinnati. Results indicated peaks for Zr^{95}-Nb^{95}, $Ru^{103-106}$ and $Ce^{141-144}$ were consistently in the ratio of 6:2:3. Fission product activity of these samples taken in March 1959 indicated an approximate age of about 120 days which would reflect the atmospheric injections of various test series occurring in the fall of 1958.

Decontamination

If necessary the external surfaces of aircraft are cleansed with solvent, then washed with a detergent and water. Pan-American routinely cleaned any surface exhibiting activity of 3 mr/hr beta and gamma. By washing at those levels, the undertaking of a full radiation protection system was not necessary.

Cosmic Radiation Exposure

Cosmic ray exposure results from high energy protons (billions of electron volts) which transfer their kinetic energy to molecules of nitrogen and oxygen in the air to produce secondary particles of positively and negatively charged electrons, mesons and photons. Cosmic rays are generally divided into hard and soft components. The soft component represents that which is absorbed in 10 centimeters of lead. The secondary particles are associated with this.

Table 5 is intended to illustrate some relative approximate doses for different latitudes and altitudes. Assumptions in the calculation for absorbed doses include:

(1) exposures at various sites with no shielding,

(2) similar biological response for all types of radiation,

(3) equivalent absorption in soft tissue using 2.08×10^9 ion pairs (i.p.) per cc of air per roentgen, and

(4) an absorbed dose from 200 Mev particles (average energy of secondaries) being similar to that from lower energy particles.

Exposure to cosmic rays at 40,000 feet altitude in the temperate latitudes for 80 hours/month* may double the radiation dose that might be received from the average total background radiation of 125 mrem estimated at sea level.[6]

The latitude effect reflects minimal values at the equator rising to a peak in the north and south temperate latitudes and is reminiscent of the observed latitudinal variation in Sr^{90} deposition from weapons testing (the causal mechanisms of both curves are different).

With increased commercial air travel contemplated at altitudes in excess of 80,000 feet, it appears that this source of exposure to man requires more study to determine its significance. Such questions--regarding the increase in secondaries from attenuation in the aircraft skin, the relative biological effect for these particles of 200 Mev intensity, and the biological effects of positive pi mesons which decay before reaching the earths surface--need to be answered.

[6]See references on p. 89.

TABLE 5.--ESTIMATE OF COSMIC RAY EXPOSURE

Latitude	Altitude (feet)	i.p./cc air/sec[7,8]	Length of exp./yr.	Sec/yr.	i.p./cc air/yr.	mrem/yr. (soft tissue)
All lat...	Sea level	2	12 mo./yr.	3.15×10^7	6.3×10^7	30
All lat...	10,000	10	12 mo./yr.	3.15×10^7	3.15×10^7	150
40° N....	40,000	200	*80 hrs./mo.	3.4×10^6	6.8×10^8	328
40° N....	54,000	260	80 hrs./mo.	3.4×10^6	8.8×10^8	425
3° N.....	54,000	90	80 hrs./mo.	3.4×10^6	3.1×10^8	147

[7], [8]See references on p. 89.

*Standard flight time of U. S. aircarrier crews.

Table 5 is predicated on an equivalent absorption in soft tissue using 2.08×10^9 ion pairs per cc of air per roentgen. Although the energy absorbed in people varies considerably with the type of particle being considered and the possibility of additional secondary particles being formed while passing through the aircraft, the table is intended to serve as a rough approximation to illustrate this exposure to cosmic ray radiation.

This increase in external radiation from natural background, including extraterrestial or cosmic activity, was recorded on March 17, 1960, in a DC-8 both during the ascent at Long Beach, California, and the descent over Miami, Florida, using a Thyac 389C Serial No. 930 portable field survey instrument. The readings are recorded in table 6.

TABLE 6.--BETA-GAMMA ACTIVITY DURING AIRCRAFT ASCENT AND DESCENT--MARCH 17, 1960

Ascent at Long Beach		Descent at Miami	
Altitude (feet)	Activity (mr/hr)	Altitude (feet)	Activity (mr/hr)
0.....	0.01	33,000	0.20
2,000.....	0.02	32,500	0.12
4,000.....	0.02	30,000	0.13
5,000.....	0.03	29,000	0.11
6,000.....	0.02	28,000	0.10
8,000.....	0.03	25,000	0.08
10,000.....	0.025	24,000	0.08
12,000.....	0.030	18,000	0.05
14,000.....	0.03	17,000	0.03
16,000.....	0.035	16,000	0.03
18,000.....	0.040	14,000	0.03
20,000.....	0.05	10,000	0.02
21,000.....	0.05	9,000	0.02
23,000.....	0.09	4,000	0.01
24,000.....	0.08	2,000	0.01
26,000.....	0.09	0	0.01
27,500.....	0.10		
28,000.....	0.09		
29,000.....	0.11		
30,000.....	0.11		
32,000.....	0.15		
32,500.....	0.16		
33,100.....	0.20		

Readings of 0.4 mr/hr were recorded at 31,000 feet on October 17, 1959, on a flight from Seattle to Bermuda in a Boeing 707. The readings of 0.4 mr/hr cannot be related to dose due to the energy response characteristic of the instrument and the secondary particle energy spectrum which is measured at altitudes in excess of 30,000 feet. An average reading would be 1600 dpm using a geiger tube instrument with a window thickness of 30 mg/cm^2.

From the data of Millikan, Neher and Pickering, reported in Physical Review, 61,397 (1942), the cosmic ray intensity is 135 ions/cc air/sec at an altitude of 35,000 feet in the northern United States (latitude greater than 40°). For an individual flying 80 hours per month at this altitude it would amount to 0.46×10^9 ion/cc/yr. This would amount to an exposure dose of 220 milliroentgens per year. Thus it may be seen that the major radiation exposure during commercial jet aircraft travel is not from fission product exposure but from cosmic or natural radioactivity.

References

1. "Biological Effects of Atomic Radiation. Report of Committee on Meteorological Aspects of the Effects of Atomic Radiation," National Academy of Sciences, National Research Council.

2. "Stratospheric Radioactivity Data Obtained by Balloon Sampling," J. Z. Holland. Hearings Before the Joint Committee on Atomic Energy on Fallout from Nuclear Weapons Tests, 86th Congress, May 1959, Vol. I, p. 592.

3. "Aircraft Contamination from Residual Stratospheric Nuclear Weapon Debris," Report TN-59-5, USAF Special Weapons Project, July 1959.

4. "Analysis of Stratospheric Sr^{90} Measurements," L. Machta and R. J. List, U. S. Weather Bureau. Congressional Hearings on Fallout from Nuclear Weapons Tests, Joint Committee on Atomic Energy, May 1959, Vol. I, p. 742.

5. "Report on Investigation of the Surface Contamination of a British European Airways Viscount 806 at London Airport," November 1959, Ministry of Health and Medical Research Council, Radiological Protection Service.

6. "Further Investigation of Natural Environmental Radiation," HASL-73, Health and Safety Laboratory, Atomic Energy Commission, November 3, 1959.

7. "Nuclear and Radiochemistry," Friedlander, Gerhart, and Kennedy, J. W., John Wiley & Sons, Inc., November 1957.

8. "Source Book on Atomic Energy," Glasstone, Samuel, D. Van Nostrand Co., Inc., 1958.

OFF-SITE ANIMAL INVESTIGATION PROJECT*

Atomic Energy Commission

In 1957, the AEC inaugurated an "Off-Site Animal Investigation Project." This consisted of establishing and maintaining a herd of about 45 Hereford cattle on the Nevada Test Site in Nevada. The objective of the project was to enhance the NTS off-site/rancher relationship through an active project in their interests, and further to provide information as to the status of the off-site animals in their environment, with special interest on the radioactive isotope uptake from fallout. Periodically animals representing both sexes and the various age groups were sacrificed. The herd is moved to allow the cattle to forage in areas where there is a maximum availability of fission products.

In 1958 the University of Nevada which maintained similar herds located at Caliente, Nevada (Delamar Valley = DV) and at Contact, Nevada (Knoll Creek = KC), under its contract with the Atomic Energy Commission's Division of Biology and Medicine, altered its sacrificing schedule to coincide with those of the NTS herds. Five animals from each of the three herds are sacrificed twice yearly. The animals lost through sacrificing have generally been replaced by calves.

Several laboratories cooperate in conducting analyses for the various radionuclides as follows:

Iodine-131—University of Tennessee and University of Nevada
Strontium-90—Health and Safety Laboratory, Atomic Energy Commission
Gamma scan--Los Alamos Scientific Laboratory
Cesium-137—Reynolds Electrical and Engineering Company, Inc.
Plutonium--University of California at Los Angeles, Atomic Energy Project
Pathological Examination—Armed Forces Institute of Pathology

*Summarized from Second and Third Annual Report, entitled "Off Site Animal Investigation Project," by Major Garland Farmer, VC, U. S. Army, Office of Test Operations, Atomic Energy Commission, Las Vegas Nevada.

TABLE 1.—DATA ON SACRIFICED ANIMALS

Code number	Area	Date sacrificed	Age	Sex	Weight (lb.)
B-22-57	NTS	Nov. 29, 1957	6 mo.	M	-
B-23-57	NTS	Dec. 2, 1957	1 yr.	F	-
B-24-57	NTS	Dec. 2, 1957	6 mo.	M	-
B-25-57	NTS	Dec. 4, 1957	1 yr.	F	-
B-34-57	NTS	Dec. 12, 1957	7 yr.	F	-
B-27-57	DV	Dec. 5, 1957	1 yr.	M	-
B-28-57	DV	Dec. 6, 1957	9 yr.	F	-
B-29-57	DV	Dec. 6, 1957	6 mo.	M	-
B-30-57	DV	Dec. 6, 1957	1 yr.	M	-
B-31-57	DV	Dec. 9, 1957	9 yr.	F	-
B-32-57	DV	Dec. 9, 1957	6 mo.	F	-
B-8-58	KC	May 20, 1958	Aged	F	-
B-9-58	KC	May 20, 1958	1 yr.	-	-
B-10-58	KC	May 20, 1958	1 mo.	-	-
B-11-58	DV	May 27, 1958	Aged	F	-
B-12-58	DV	May 27, 1958	1 yr.	-	-
B-13-58	DV	May 27, 1958	3 mo.	-	-
B-14-58	NTS	June 2, 1958	1 yr.	-	-
B-15-58	NTS	June 3, 1958	2 yr.	-	-
B-16-58	NTS	June 3, 1958	Aged	F	-
B-17-58	NTS	June 3, 1958	1 mo.	-	-
B-18-58	KC	Nov. 6, 1958	5 yr. 6 mo.	F	930
B-19-58	KC	Nov. 6, 1958	2 yr. 6 mo.	F	920
B-20-58	KC	Nov. 6, 1958	1 yr. 6 mo.	M	430
B-21-58	KC	Nov. 6, 1958	10 da.	M	90
B-22-58	DV	Nov. 14, 1958	Aged	F	670
B-23-58	DV	Nov. 14, 1958	2 yr. 6 mo.	M	635
B-24-58	DV	Nov. 14, 1958	1 yr. 7 mo.	M	390
B-25-58	DV	Nov. 14, 1958	5 mo.	M	245
B-26-58	NTS	Nov. 21, 1958	Aged	F	880
B-27-58	NTS	Nov. 21, 1958	2 yr.	F	700
B-28-58	NTS	Nov. 21, 1958	1 1/2 yr.	F	650
B-29-58	NTS	Nov. 21, 1958	7 mo.	M	275
B-30-58	NTS	Apr. 23, 1959	Aged	F	790
B-31-58	NTS	Apr. 23, 1959	2 yr. 6 mo.	M	750
B-32-59	NTS	Apr. 23, 1959	1 yr. 10 mo.	M	670
B-33-59	NTS	Apr. 23, 1959	1 mo.	M	110
B-34-59	DV	Apr. 30, 1959	Aged	F	750
B-35-59	DV	Apr. 30, 1959	2 yr.	F	475
B-36-59	DV	Apr. 30, 1959	1 yr.	M	325
B-37-59	DV	Apr. 30, 1959	3 wk.	M	95
B-38-59	KC	May 7, 1959	6 yr.	F	1,115
B-39-59	KC	May 7, 1959	2 yr.	F	490
B-40-59	KC	May 7, 1959	1 yr.	M	430
B-41-59	KC	May 7, 1959	3 mo.	M	255
B-45-59	DV	Nov. 3, 1959	10 yr.	F	720
B-46-59	DV	Nov. 3, 1959	3 yr.	F	505
B-47-59	DV	Nov. 3, 1959	2 yr.	F	630
B-48-59	DV	Nov. 3, 1959	1 yr.	M	370
B-49-59	DV	Nov. 3, 1959	8 mo.	M	180
B-50-59	NTS	Nov. 12, 1959	Aged	F	750
B-51-59	NTS	Nov. 12, 1959	2 yr.	M	950
B-52-59	NTS	Nov. 12, 1959	3 yr.	M	900
B-53-59	NTS	Nov. 12, 1959	1 yr.	M	350
B-54-59	NTS	Nov. 12, 1959	5 mo.	M	180
B-55-59	KC	Nov. 19, 1959	10 yr.	F	970
B-56-59	KC	Nov. 19, 1959	3 yr.	F	775

TABLE 1.--DATA ON SACRIFICED ANIMALS--Con.

Code number	Area	Date sacrificed	Age	Sex	Weight (lbs.)
B-57-59	KC	Nov. 19, 1959	2 yr.	F	1,000
B-58-59	KC	Nov. 19, 1959	1 yr.	M	580
B-59-59	KC	Nov. 19, 1959	5 mo.	M	170
B-60-60	DV	Apr. 22, 1960	4 yr.	F	665
B-61-60	DV	Apr. 22, 1960	3 yr.	F	625
B-62-60	DV	Apr. 22, 1960	2 yr.	F	380
B-63-60	DV	Apr. 22, 1960	1 1/4 yr.	F	220
B-64-60	DV	Apr. 22, 1960	1 mo.	F	75
B-65-60	NTS	Apr. 29, 1960	5 yr.	F	680
B-66-60	NTS	Apr. 29, 1960	3 yr.	M	850
B-67-60	NTS	Apr. 29, 1960	2 yr.	M	450
B-68-60	NTS	Apr. 29, 1960	1 yr.	F	300
B-69-60	NTS	Apr. 29, 1960	3 wks.	F	80
B-70-60	KC	May 7, 1960	6 yr.	F	965
B-71-60	KC	May 7, 1960	3 yr.	F	900
B-72-60	KC	May 7, 1960	2 yr.	F	790
B-73-60	KC	May 7, 1960	1 yr.	F	463
B-74-60	KC	May 7, 1960	2 mo.	F	160

The following tables present the analytical data collected from samples taken from animals in the three herds.

TABLE 2.—IODINE-131 DATA

Code number	I^{131} content of thyroid tissue at time of death (μμc/gm)	Code number	I^{131} content of thyroid tissue at time of death (μμc/gm)
B-18-58	4,420	B-30-59	40
B-19-58	4,490	B-31-59	10
B-20-58	5,870	B-32-59	8
B-21-58	7,550	B-33-59	8
B-38-59	25	B-60-60	15
B-39-59	18	B-61-60	08
B-40-59	7	B-62-60	16
B-41-59	23	B-63-60	20
B-22-58	5,890	B-64-60	12
B-23-58	6,500	B-65-60	12
B-24-58	9,980	B-66-60	13
B-25-58	8,160	B-67-60	15
B-34-59	20	B-68-60	19
B-35-59	30	B-69-60	10
B-36-59	10	B-70-60	3
B-37-59	8	B-71-60	5
B-26-58	7,350	B-72-60	3
B-27-58	124,560	B-73-60	2
B-28-58	156,540	B-74-60	2
B-29-58	161,770		

TABLE 3.—STRONTIUM-90 BONE DATA

Code number	Type bone	Percent Ca in ash	uuc/gm Ca
B-22-57.....	Proximal 1/3 of femur	36.8	19.3
	Eighth coste chondral jct	34.5	32.3
B-23-57.....	Proximal 1/3 of femur.....	37.4	11.8
	Eighth coste chondral jct	35.8	10.1
B-24-57.....	Proximal 1/3 of femur.....	37.2	10.2
	Eighth coste chondral jct	39.8	9.2
B-25-57.....	Proximal 1/3 of femur.....	36.7	13.0
	Eighth coste chondral jct	35.6	13.2
B-34-57.....	Proximal 1/3 of femur.....	38.1	15.1
	Eighth coste chondral jct	37.1	13.4
B-27-57.....	Proximal 1/3 of femur.....	37.3	14.4
	Eighth coste chondral jct	35.6	17.6
B-28-57.....	Proximal 1/3 of femur.....	38.1	10.8
	Eighth coste chondral jct	35.6	9.4
B-29-57.....	Proximal 1/3 of femur.....	35.7	15.0
	Eighth coste chondral jct	35.8	24.0
B-30-57.....	Proximal 1/3 of femur.....	35.3	16.6
	Eighth coste chondral jct	33.8	16.5
B-31-57.....	Proximal 1/3 of femur.....	38.0	5.6
	Eighth coste chondral jct	38.2	7.0
B-32-57.....	Proximal 1/3 of femur.....	37.8	17.8
	Eighth coste chondral jct	37.5	18.9
		gm Ca/kg orig. matl.	
B-18-58.....	Rib.....	27.9	15.6
	Femur.....	5.1	11.6
	Duplicate femur	5.6	19.2
B-19-58.....	Rib.....	21.1	26.3
	Femur.....	5.6	19.4
B-20-58.....	Rib.....	27.2	10.7
	Femur.....	11.0	34.5
B-21-58.....	Rib.....	24.6	23.7
	Femur.....	26.3	14.8
B-8-58.....	Rib.....	26.2	14.3
	Femur.....	4.7	28.9
	Triplicate femur	4.7	17.2
	Triplicate femur	4.5	19.9
B-9-58	Rib.....	46.8	4.5
	Femur.....	10.8	37.9
B-10-58.....	Rib.....	21.7	18.2
	Femur.....	25.0	7.0
B-11-58.....	Rib.....	37.4	6.8
	Femur.....	7.3	3.9
B-12-58.....	Rib.....	42.2	30.0
	Femur.....	8.6	21.0
	Duplicate femur	8.6	27.8
B-13-58.....	Rib.....	27.1	16.0
	Femur.....	27.2	18.3
B-22-58.....	Rib.....	25.3	8.8
	Femur.....	6.5	9.3
B-23-58.....	Rib.....	29.0	14.1
	Femur.....	6.8	12.7
B-24-58.....	Rib.....	33.4	9.8
	Femur.....	13.5	14.8
B-25-58.....	Rib.....	24.2	5.8
	Femur	14.2	20.4

TABLE 3.—STRONTIUM-90 BONE DATA—Con.

Code number	Type bone	gm Ca/kg orig. matl.	uuc/gm Ca
B-26-58.....	Rib.....	17.3	6.4
	Femur.....	9.4	15.4
	Duplicate femur.....	9.7	17.2
B-27-58.....	Rib.....	23.4	3.8
	Femur.....	6.2	18.5
B-28-58.....	Rib.....	28.0	8.5
	Femur.....	6.9	28.2
	Duplicate femur.....	6.9	29.3
B-29-58.....	Rib.....	13.9	10.8
	Femur.....	13.6	44.8
B-14-58.....	Rib.....	22.2	3.7
	Femur.....	11.7	7.2
B-15-58.....	Rib.....	43.8	7.3
	Femur.....	7.2	19.8
B-16-58.....	Rib.....	-	8.2
	Femur.....	-	9.6
B-17-58.....	Rib.....	55.3	15.2
	Femur.....	7.4	27.9

TABLE 4.—STRONTIUM-90 IN RUMEN

Code number	gm Ca/kg orig. matl.	uuc/gm Ca	Code number	gm Ca/kg orig. sample	uuc/kg orig. sample	uuc/gm Ca
B-22-57..	7.0	333	B-8-58	5.0	817	163
B-23-57..	4.8	473	B-9-58	3.8	579	154
		453				
B-24-57..	5.5	566	B-10-58	10.1	2,000	200
B-25-57..	10.7	221	B-11-58	3.8	272	72.0
		221				
B-27-57..	9.6	144	B-12-58	3.4	266	78.9
B-28-57..	5.9	86	B-13-58	9.4	166	17.7
B-29-57..	4.2	192	B-17-58	15.4	1,160	75.3
B-30-57..	7.0	134	B-18-58	4.3	924	215
B-31-57..	11.4	67	B-19-58	5.5	1,340	244
B-32-57..	10.3	77	B-20-58	4.6	1,070	235
B-34-57..	6.3	600	B-22-58	14.6	1,200	82.2
			B-23-58	30.9	1,020	33.0
			B-24-58	12.5	488	39.0
			B-25-58	15.5	1,140	73.5
			B-26-58	10.8	730	67.6
			B-27-58	7.3	1,310	180
			B-28-58	9.9	1,760	177
			B-29-58	5.5	1,153	209

TABLE 5.—STRONTIUM-90 IN FECES

Area	Date	gm Ca/kg orig. matl.	μμc/kg orig. matl.	μμc/gm Ca
NTS	1957	16.0	-	581 623
DV	1957	33.0	-	111 95
DV	Nov. 21, 1958	21.0	1,160	55
NTS Well No. 3	Jan. 27, 1959	19.8	3,830	193
KC	Nov. 1958	6.5	2,130	329
KC	May 20, 1958	31.7	2,530	80
DV	May 27, 1958	26.7	1,653	62
NTS Area 13	June 3, 1958	28.9	5,480	190

Gamma ray spectrometry was conducted on ashed rumen and fecal samples, for May 1958 and for November 1958.

TABLE 6.—GAMMA RAY SPECTROMETRY

Code number	Sample	mμc/kg original material			
		Zr^{95}	Nb^{95}	Ce^{144}	Ru^{106}
B-8-58	Rumen	21	42	20	1.3
B-9-58	Rumen	18	32	20	1.4
B-10-58	Rumen	56	110	80	4.4
B-11-58	Rumen	1.5	2.8	2.5	0.2
B-12-58	Rumen	1.6	3.2	3.5	0.2
B-13-58	Rumen	12	25	15	1.2
B-17-58	Rumen	43	88	62	6.2
B-24-58	Rumen	50.7	101	37.4	2.2
B-25-58	Rumen	68.3	136	48.6	3.5
B-22-58	Rumen	54.9	109	28.2	2.3
B-23-58	Rumen	55.3	111	45.6	2.5
B-28-58	Rumen	243	488	142	13.8
B-29-58	Rumen	206	415	121	11.7
B-26-58	Rumen	181	364	107	13.4
B-27-58	Rumen	226	454	167	13.8
B-19-58	Rumen	23.6	47.8	32.4	1.6
B-20-58	Rumen	24.8	49.5	32.2	1.9
B-18-58	Rumen	20.6	41.2	27.7	1.7
DV-1-58	Fecal	47	93	43	3.2
NTS-1-58	Fecal	20	39	37	1.8
KC-1-58	Fecal	50	100	56	3.1
DV-2-58	Fecal	15.9	31.6	23.3	1.4
NTS-2-58	Fecal	366	745	250	22.8

NOTE: Fecal samples are from areas indicated, not from individual animals.

TABLE 7.—RADIOACTIVITY OF TISSUE

Sample	Date	gmK/kg orig. matl.	Cs^{137}		Zr^{65}	Other
			μμc/gmK	μμc/kg orig. matl.	μμc/kg orig. matl.	
NTS Muscle.....	Dec. 1957	3.9	100	390	None	
DV Muscle.....	Dec. 1957	3.8	93	350	None	
Muscle—3 herds pooled	May 1958	3.9	120	470	None	
Liver—3 herds pooled..	May 1958	-	-	230	-	Tr. Zr^{95}, $RuRh^{103-106}$
Bone—3 herds pooled....	May 1958	-	-	None	-	Tr. $BaLa^{140}$, Zr^{95}
Muscle—3 herds pooled	Nov. 1958	4.7	160	770	140	$RuRh^{103-106}$, Zr^{95}
Liver—3 herds pooled..	Nov. 1958	5.2	68	350	323	$RuRh^{103-106}$, Zr^{95}
Bone—3 herds pooled....	Nov. 1958	Tr.	Tr.	Tr.	Tr.	$BaLa^{140}$, $3x10^4$ μμc/kg, Tr. Zr^{95}

Tr. = Trace.

TABLE 8.—PLUTONIUM ANALYSIS

Code number	Type sample	dpm/gm bone ash	Code number	Type sample	dpm/gm bone ash
B-8-58....	Rib	0.02	B-13-58..	Rib	Bkg
	Femur	0.01		Femur	0.03
B-9-58....	Rib	0.02	B-14-58..	Rib	0.07
	Femur	0.05		Femur	Bkg.
B-10-58..	Rib	0.03	B-15-58..	Rib	Bkg.
	Femur	0.03		Femur	Bkg.
B-11-58..	Rib	0.08	B-16-58..	Rib	Bkg.
	Femur	0.09		Femur	0.02
B-12-58..	Rib	0.04	B-17-58..	Rib	0.02
	Femur	0.04		Femur	0.03

Note: Rib includes distal 1/3 of rib and coste-chondral junction.
Femur includes 1/3 of shaft and head.

In referring to the iodine data presented in table 1, it should be noted that levels of iodine are consistently low except for the period of Hardtack II Operation (Fall 1958). Taking the body-thyroid weight ratio of the animal, it is found that a 0.7 microcurie level, which constitutes a maximum permissible limit (NBS Handbook 69), is present in the NTS herd three weeks after the end of the Operation. The source of this iodine has been questioned since it is not believed that such an amount was present from surface or altitude shots; hence, there is speculation as to its origin. One explanation advanced was the volatile gases, including I^{131}, from sub-surface shots permeated the earth above the shot point. The gases were then carried by down-drafts to the valley floor where the plant life scavenged the iodine from the air. This is questionable due to the reactive nature of iodine. The amount of iodine observed would require an explanation other than that from altitude shots only. However, it illustrates the point that biological monitoring may be more sensitive to certain isotopes than the mechanical monitors used. Nevertheless, only the NTS herd was above the human MPL, but not by a large factor. Considering that these cattle were not exposed continuously to these levels but only shortly thereafter (note very low May 1959 levels), biological effects are improbable.

The levels of strontium-90 found at the NTS are not significantly higher than the other two off-site areas. The difference in the Sr/Ca ratio between rib and femur in the 1957 data is very small; however, in the 1958 data, the differences become considerably larger (the extreme case is B-9-58, where the rib to femur ratio is 8.5). This seems unreasonable from a biological point of view, although the blind duplicates and triplicates agree quite well. The results of averaging the herds on a yearly basis are as follows:

Herd	Date sacrificed	Av. μμc Sr^{90}/gm Ca
NTS.....	November-December 1957	14.7
DV.....	December 1957	14.5
NTS.....	May-November 1958	14.8
DV.....	May-November 1958	13.9
KC.....	May-November 1958	18.8

All values are essentially the same, and there seems to be no dependence of the strontium to calcium ratio on herd location or year. Possibly the Knoll Creek herd is an exception, showing somewhat higher strontium to calcium ratios because it is on the Nevada-Idaho border where stratospheric fallout is greater.

All reports which have been returned from the Armed Forces Institute of Pathology indicate nothing significant from the microscopic pathological examination. To date, there has been no gross effect observed. Their reproduction rate is normal and the animals maintain themselves in a satisfactory state. There have been no diseased conditions in the herd which would suggest ill health or substandard resistance. Since there have been no weapons tests and subsequent release of fallout material, the uptake of isotopes has been negligible. After three years, it may be concluded that there has been no noticeable radiation damage to this herd. The project remains of interest to the local ranchers who inquire closely about the welfare of the herd. It serves a very useful purpose in furthering Test Site-rancher understanding and relations. It is felt that it is quite important to continue the herd and project, even though tests have ceased, as this will enable a base line of isotope uptake to be established for future reference.

HUMAN BONE SAMPLING PROGRAM OF THE CANADIAN RADIOACTIVE FALLOUT STUDY PROGRAM

Human bone samples have been collected and analysed for strontium-90 since 1957 by various pathology departments cooperating in the program of the Radiation Protection Division, Department of National Health and Welfare, Dominion of Canada.

Although many of the samples are autopsy specimens of persons who died of diseases, it is believed that the experimental data will provide a better measure of the potential health hazard from strontium-90 than milk values because the effect of strontium-90 on the body results principally from the amount retained in bone.

More detailed discussion of the sampling procedures, method of analysis, and interpretation of results of the Department's radioactive fallout program is contained in the "Annual Report for 1959," Report Number CNHW (RP-3). The data tables and conclusions from this report are reproduced on the following pages by permission of the above Division of the Canadian Government.

Conclusions

1. The results of total beta particle measurements in precipitation samples collected from a small network during the first half of 1959 indicate that the deposition of radioactive fission products reached a peak in the second quarter of 1959. The results of total beta particle measurements in both air and precipitation samples collected from a larger nation-wide network of stations indicate that the deposition of radioactive fission products decreased considerably in the last half of 1959.
2. The results of the measurement of strontium-90 in milk powder samples indicate that the average level reached a peak in June 1959, decreasing sharply to a minimum in September, followed by an apparent increase again towards the end of the year. The overall increase was about the same as that for 1958.
3. The results of the measurement of strontium-90 in human bone samples show that as expected the level is higher in children than in adults. There is some evidence in favor of a non-uniform distribution of strontium-90 by bone type in adults and of a uniform distribution in children. Calculated levels of strontium-90 in adults using the 1958 ICRP data are in remarkably good agreement with experimental results.

The levels of strontium-90 in bone samples collected during 1957 and 1958, from both adults and children, were well below the maximum permissible recommended by the ICRP. Calculations indicate that this situation will still apply for 1959 and 1960 bones.

FIGURE I

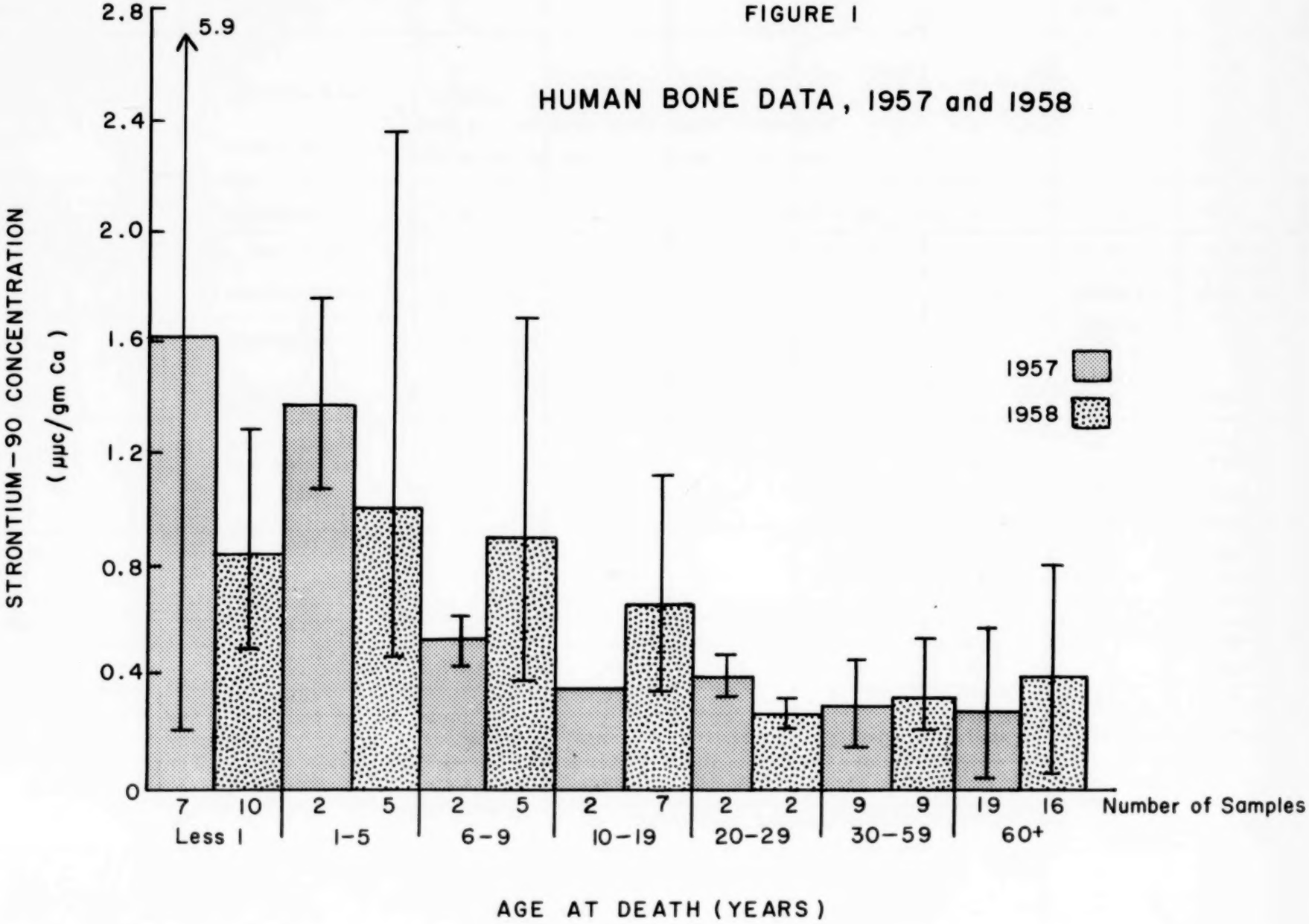

HUMAN BONE DATA, 1957 and 1958
STRONTIUM-90 CONCENTRATION
(μμc/gm Ca)
2.8
2.4
2.0
1.6
1.2
0.8
0.4
0
5.9
1957
1958
7 10 2 5 2 5 2 7 2 2 9 9 19 16
Number of Samples
Less 1
1-5
6-9
10-19
20-29
30-59
60+
AGE AT DEATH (YEARS)

TABLE 1.—HUMAN BONE DATA 1957

(Strontium-90 content per gram of calcium)

Location	Bone type	Age at death (assumed to have occurred in 1957)						
		0-12 mo	1-5 yr	6-9 yr	10-19 yr	20-29 yr	30-59 yr	60+ yr
		uuc/gmCa	uuc/gmCa	uuc/gmCa	uuc/gmCa	uuc/gmCa	uuc/gmCa	uuc/gmCa
Edmonton	Vertebrae					0.47	0.45	0.58 0.28
	Rib					0.32		0.42
Montreal	Vertebrae						0.27(3) 0.29 0.34	0.39(1) 0.39(2) 0.31
	Rib			0.44				0.39(2)
	Long bone						0.08(3)	0.10(1)
	Miscellaneous							0.23(1) 0.10
Ottawa	Rib						0.33(4) 0.05(4)	0.24(5)
	Long bone						0.12(4) 0.14(4)	
	Miscellaneous						0.22(4)	0.10(5) 0.22(5) 0.06(5)
Regina	Vertebrae	0.42(6)						0.51
	Rib							0.24
	Long bone							0.09 0.17
	Miscellaneous	0.76(6)						0.19 0.06 0.26
Saskatoon	Vertebrae						0.20 0.45	0.58

TABLE 1.—HUMAN BONE DATA 1957—Con.

(Strontium-90 content per gram of calcium)

Location	Bone type	Age at death (assumed to have occurred in 1957)						
		0-12 mo	1-5 yr	6-9 yr	10-19 yr	20-29 yr	30-59 yr	60+ yr
		μμc/gmCa	μμc/gmCa	μμc/gmCa	μμc/gmCa	μμc/gmCa	μμc/gmCa	μμc/gmCa
Toronto	Vertebrae	2.37 5.9		0.62				
	Long bone				0.34(7) 0.23(7)			
	Miscellaneous	0.86 0.21 0.97 0.36	1.78 1.10		0.37 0.51(7)			
Victoria	Rib						0.18	0.31
	Miscellaneous							0.04
Winnipeg	Long bone						0.38	0.32
Average all bones		1.61	1.44	0.53	0.36	0.40	0.29	0.28
Number of subjects		7	2	2	2	2	9	19

Notes: All results with the same bracketed superscript numbers are for specimens from the same body.
Averages are obtained after first obtaining averages for each subject.

TABLE 2.--HUMAN BONE DATA 1958

(Strontium-90 content per gram of calcium)

Location	Bone type	Age at death (assumed to have occurred in 1958)						
		0-12 mo	1-5 yr	6-9 yr	10-19 yr	20-29 yr	30-59 yr	60+ yr
		μμc/gmCa	μμc/gmCa	μμc/gmCa	μμc/gmCa	μμc/gmCa	μμc/gmCa	μμc/gmCa
Charlottetown	Vertebrae			1.04[8]	0.94[10]	0.37[9]		
	Miscellaneous			0.69[8]	0.41 0.88[10]	0.26[9]		
Edmonton	Long bone						0.33	
Montreal	Vertebrae							0.32
Ottawa	Vertebrae			1.71	1.13 0.57		0.38 0.22 0.32 0.29 0.32	0.48 0.82 0.14 0.53 0.66 0.59 0.44 0.40
	Rib						0.26 0.54	
	Long bone							0.13 0.07
	Miscellaneous							0.31
Sidney	Miscellaneous	1.30						
Toronto	Vertebrae	0.56 0.80 0.68 1.05 1.13 0.63 0.69	0.53[11] 0.45 0.50[13] 0.95	0.55[14]	0.58[12] 0.78			

TABLE 2.--HUMAN BONE DATA 1958--Con.

(Strontium-90 content per gram of calcium)

Location	Bone type	Age at death (assumed to have occurred in 1958)						
		0-12 mo	1-5 yr	6-9 yr	10-19 yr	20-29 yr	30-59 yr	60+ yr
		μμc/gmCa	μμc/gmCa	μμc/gmCa	μμc/gmCa	μμc/gmCa	μμc/gmCa	μμc/gmCa
Toronto	Rib		0.58(11) 0.47(13) 2.30(15)	0.59(14) 0.39	0.42(12)			
	Long bone		2.40(15)		0.46(12)			
	Miscellaneous	0.51 1.10	1.15(11)					
Winnipeg	Vertebrae				0.36	0.21	0.34	0.12 0.71 0.65 0.41
	Long bone		0.95(16) 1.04(16)					
Average all bones		0.84	1.00	0.91	0.66	0.26	0.33	0.42
Number of subjects		10	5	5	7	2	9	16

Notes: All results with the same bracketed superscript numbers are for specimens from the same body.
Averages are obtained after first obtaining averages for each subject.

LONG TERM TRAINING ACTIVITIES OF THE DIVISION OF RADIOLOGICAL HEALTH

Public Health Service

Training activities of the Division of Radiological Health Training Branch related to the development and implementation of effective Federal, State and local radiological health services differ considerably from the short-term training courses described in November 1960 Radiological Health Data. These activities pertaining to formal academic training may be classified into three areas: "Outside-Service" Training, Training Grants, and University Liaison Services.

"Outside-Service" Training involves selection and assignment of Commissioned Corps and Civil Service officers for one or more years of full-time graduate study in radiation biology and other curricula related to radiological health. In its current program to qualitatively and quantitatively improve staff competency, the Public Health Service has over 30 officers enrolled in preparation for future work assignments. During Fiscal Year 1960, 24 officers were enrolled. It is estimated that between 30 and 50 additional officers per year will be trained during the next two years.

In the Division's Training Grants Program, funds are made available to universities and other institutions to strengthen their programs for training radiation health specialists through improvement and enrichment of existing curricula and development and establishment of new study courses. Initiated in response to estimates of critical shortages of qualified personnel, as presented by the National Advisory Committee on Radiation, this program has received an allocation of $500,000 for Fiscal 1961. Grants are awarded upon approval by a NACOR training subcommittee. Applying institutions are required to state their current and planned activities in radiological health and the amount of funds needed. Continued expansion of the Training Grants Program is expected.

University Liaison Services are a continuing responsibility maintained by the Division of Radiological Health to assist educational institutions to plan curricula and to solve related problems. Typical of such Divisional activity was the August 1960 symposium, "University Curricula in Radiological Health," which it sponsored at Princeton, New Jersey. Over 100 representatives of interested institutions attended the meeting to discuss courses of study, personnel and equipment requirements, and other relevant needs in terms of training objectives. The interest generated by the many participants and attendees at meetings of this kind is expected to help assure adequate attention to the scope of radiological health in future curriculum planning.

ENVIRONMENTAL LEVELS OF RADIOACTIVITY AT ATOMIC ENERGY COMMISSION INSTALLATIONS

The United States Atomic Energy Commission provides data on the environmental levels of radioactivity in the vicinity of major Commission installations to the Public Health Service on a quarterly basis.

The November and December 1960 issues of Radiological Health Data summarized the 1959 and the first quarter 1960 reports for fifteen installations. Second quarter 1960 reports for four of these installations appeared in the January 1961 issue. This month, four additional second quarter reports are summarized in the following sections.

AIRCRAFT NUCLEAR PROPULSION DEPARTMENT

General Electric Company
Cincinnati, Ohio

August 1960

Environmental levels of radioactivity at the Aircraft Nuclear Propulsion Department (ANPD) for 1959 and first quarter 1960 were reported in the November 1960 Radiological Health Data. The following report presents a summary of the data for the second quarter of 1960.

The Cincinnati facilities of the ANPD are located within the metropolitan area, approximately 11 miles north of the main business district. The buildings lie approximately on the centerline of a wide valley at an elevation of 560 feet above sea level. The east fork of the Mill Creek, which flows into the Ohio River, runs several hundred feet east of the buildings (see figures 1 and 2).

The data obtained by the off-site monitoring program for alpha and beta-gamma airborne radioactivity are presented in table 1. Since airborne radioactivity can arise from many sources, such as natural deposits in the earth, fallout from weapons tests and discharges from atomic plants, the results obtained from the stack effluent air monitoring program are also presented in table 2.

TABLE 1.—OFF-SITE AIRBORNE RADIOACTIVITY

(Average concentrations in $\mu\mu c/m^3$)

Period	Location	Number samples	Long-lived alpha	Number samples	Beta-gamma
Second quarter 1960	Upwind	117	0.048	78	0.45
	Downwind	270	.055	180	.59
April.....	Upwind	27	.049	18	.54
	Downwind	99	.068	66	.84
May	Upwind	36	.050	24	.55
	Downwind	81	.043	54	.65
June	Upwind	54	.046	36	.27
	Downwind	90	.054	60	.27

TABLE 2.--STACK EFFLUENT AIR MONITORING

Second Quarter 1960

(Average concentrations in $\mu\mu c/m^3$)

Exhaust stack	Number samples	Alpha	Number samples	Beta-gamma
Main	111	0.004	111	0.09
Secondary	258	0.0009	93	0.07

Comparison of average stack effluent air concentrations of alpha and beta-gamma radioactivity with the average downwind concentrations detected in the off-site monitoring program during similar periods of time indicates that ANPD contributed negligible amounts of radioactivity to the atmosphere of the environs. In fact, even without consideration of the dilution that takes place with the atmosphere at the point of release, the effluent concentrations were notably less than the environmental levels, both upwind and downwind.

An extensive fallout sampling program continued to be followed. Data obtained by this program were reported separately to the Atomic Energy Commission and the Technical Information Service Extension. Levels of fallout during this period were, on the whole, barely measurable.

All liquid wastes known to be contaminated with radioactive materials are shipped for disposal at the Oak Ridge National Laboratory. However, since ordinary laboratory waste water is disposed in the city sanitary sewers, such waste is retained until analyses give assurance that it can be safely discharged. Measurements of the concentrations of alpha emitters in water discharged during the second quarter of 1960 are presented in table 3.

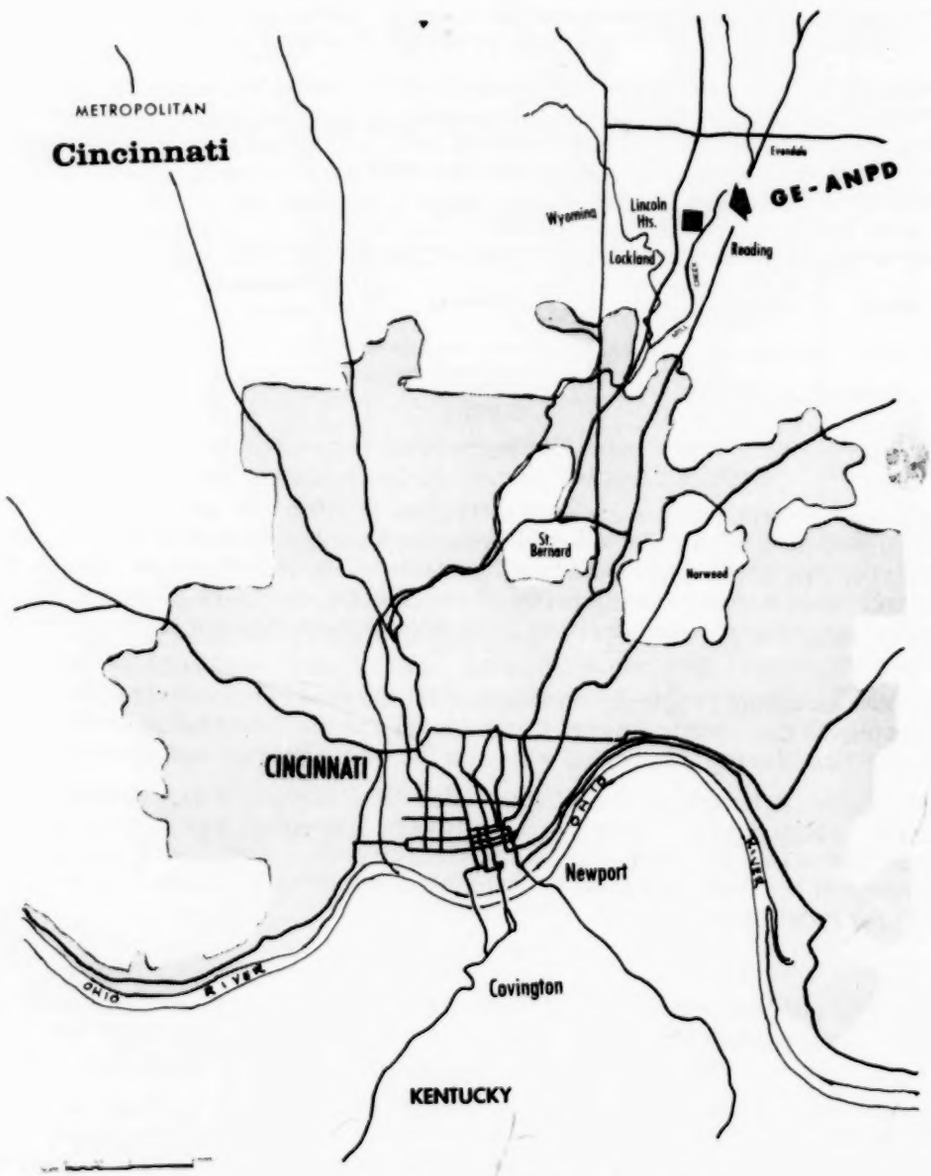
TABLE 3.--LIQUID WASTE FROM DRAIN SYSTEM

Second Quarter 1960

Period	Volume of liquid effluent (gallons)	Average concentration (μμc U/liter)
Second quarter 1960	896,500	3,000
April	275,500	4,400
May	300,500	2,100
June	320,500	2,500

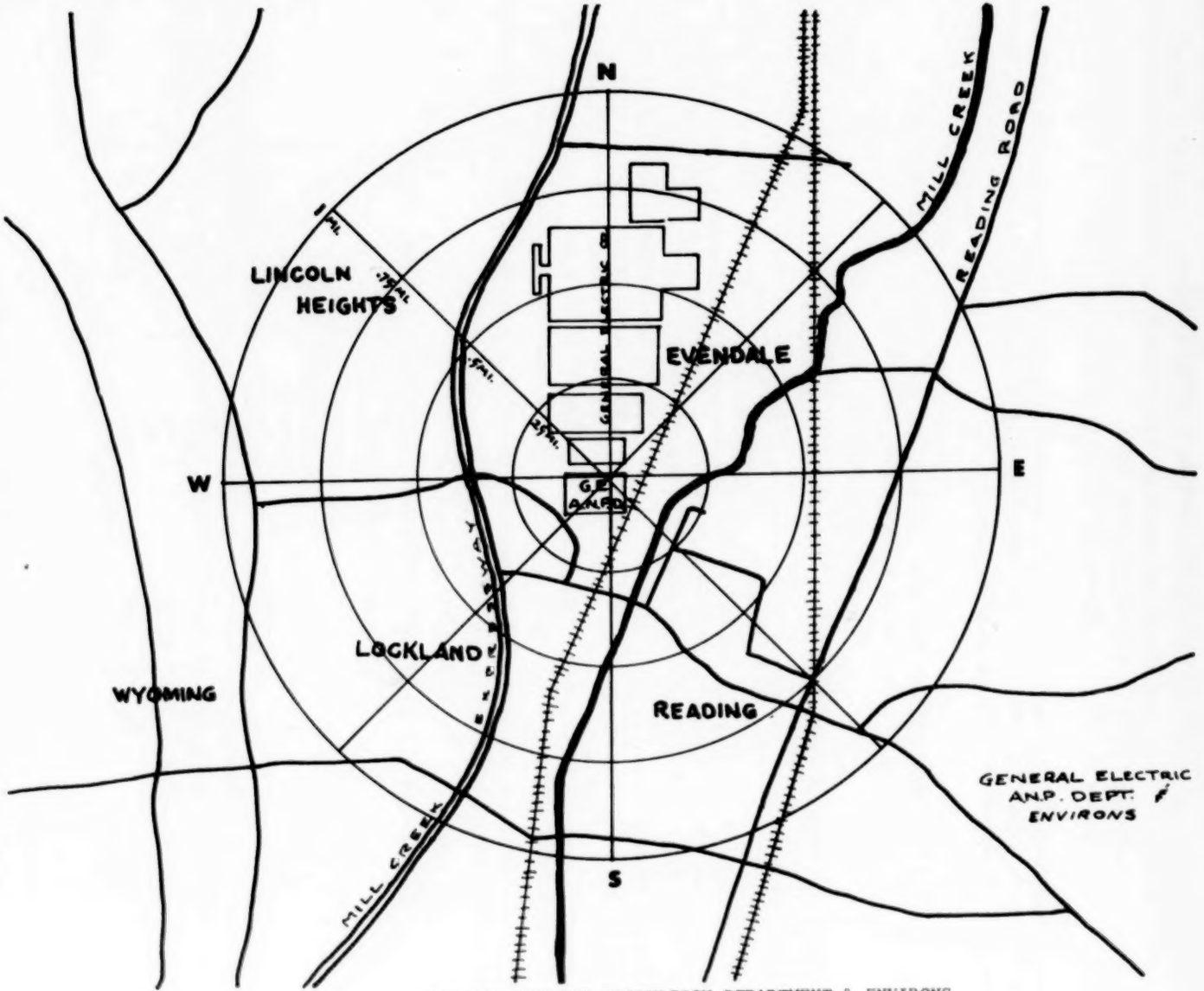
The control level of 153,200 μμc U/liter in discharge water is based upon the radioactivity concentration guide level imposed by the city of Cincinnati and anticipated volumes of dilution water.

The data obtained in the environmental airborne and liquid effluent radioactivity monitoring programs during the second quarter of 1960 indicate that the operations at ANPD contributed an insignificant amount of radioactivity to the air and liquid wastes discharged to the city of Cincinnati sewerage system.



LOCATION MAP

FIGURE 1



AIRCRAFT NUCLEAR PROPULSION DEPARTMENT & ENVIRONS

FIGURE 2

BROOKHAVEN NATIONAL LABORATORY

Associated Universities, Incorporated
Upton, New York

November 14, 1960

Environmental levels of radioactivity at the Brookhaven National Laboratory for 1959 and first quarter of 1960 were reported in the December 1960 Radiological Health Data. The following tables present the data for the second quarter of 1960.

TABLE 1.—AVERAGE RADIATION LEVELS AT BNL SITE BOUNDARY DUE TO LABORATORY OPERATIONS

Second Quarter—1960

(Average values in mr/week, from argon-41 in the reactor cooling air)

Period	N. Gate 680 m inside boundary	S. W. perimeter	S. E. perimeter	N. E. perimeter
Second quarter.....	0.70	0.18	0.40	0.75
April	0.35	0.20	0.37	0.98
May	1.17	0.12	0.49	0.64
June	0.57	0.20	0.36	0.65

The gross concentration and amount of radioactivity in the laboratory liquid waste effluent where it leaves the site is shown in table 2.

TABLE 2.—LIQUID WASTE EFFLUENT LEAVING THE BNL SITE

Second quarter—1960

Period	Volume of flow (gal/day)	Concentration of activity (uuc/liter)	Amount of activity (millicuries)
Whole quarter	817,000	96	26.4
April.....	906,000	68	7.0
May	815,000	93	8.9
June	731,000	127	10.5

CONNECTICUT AIRCRAFT NUCLEAR ENGINE

Pratt & Whitney Aircraft
Division of United Aircraft Corporation
Middletown, Connecticut

August 1, 1960

Environmental levels of radioactivity at Connecticut Aircraft Nuclear Engine Laboratory (CANEL) were reported in the November 1960 Radiological Health Data. The following report presents a summary of the data for the second quarter of 1960.

The environmental monitoring program at CANEL consists of collection and analysis of water, drinking water, Connecticut River water, process water, domestic sewer water, precipitation and air samples and measurement of external radiation levels.

Figure 1 shows a diagram of the sampling area around CANEL with the center near the center of the CANEL site. The outer circle is at a distance of five miles from the center of the site.

Water samples were collected once a month in each sector of an annulus from 3.1 through 7.4, as shown in figure 1. Sixty samples were collected in this quarter. The results are given in table 1.

TABLE 1.—ENVIRONMENTAL WATER

Second quarter—1960

Activity	Average concentration (μμc/liter)
Soluble alpha	0.30
Soluble beta.....	3.94
Insoluble alpha.....	1.31
Insoluble beta	6.09

Drinking water samples were collected from two wells in use at the CANEL site. Samples were collected once every 20 days. The well sampled at a given date was the one in use at that time. Three samples were taken in the second quarter.

TABLE 2.—DRINKING WATER—TWO WELLS

Second quarter 1960

Activity	Average concentration (μμc/liter)
Soluble alpha	0.25
Soluble beta.....	0.34
Insoluble alpha.....	0.55
Insoluble beta	5.07

Water samples were collected once a month from two separate locations along the Connecticut River. One location is near the north edge of the CANEL site and the other is near the south edge of the site. Three samples were taken at each location during the second quarter of 1960. Results were as follows:

TABLE 3.—CONNECTICUT RIVER WATER

Second quarter 1960

Location	Activity	Average concentration (μμc/liter)
North boundary of site.....	Soluble alpha	0.08
	Soluble beta	2.56
	Insoluble alpha	0.47
	Insoluble beta	5.51
South boundary of site.....	Soluble alpha	0.16
	Soluble beta	3.50
	Insoluble alpha	0.20
	Insoluble beta	2.95

Precipitation samples are collected as they occur at a central location on site, the Weather Station. A total of 31 samples was collected in the second quarter of 1960. Results were as follows:

TABLE 4.—PRECIPITATION

Second quarter 1960

Activity	Average concentration (μμc/liter)
Soluble alpha.....	1.46
Soluble beta.....	56.4
Insoluble alpha.....	0.69
Insoluble beta	17.6

Air samples were collected daily, except for week-ends and holidays, when weather permitted. These samples were collected at the weather station as well as at various locations on and around the CANEL site. The results are given in table 5.

TABLE 5.—AIR SAMPLES

Second quarter 1960

Location	Activity	No. samples	Average concentration ($\mu\mu c/m^3$)
Weather station.....	Alpha	40	0.0015
	Beta	40	0.06
On and around site.....	Alpha	19	0.0032
	Beta	19	0.30

The data from the environmental monitoring show that the radioactivity in the environment is not greatly different from those levels found in previous years.

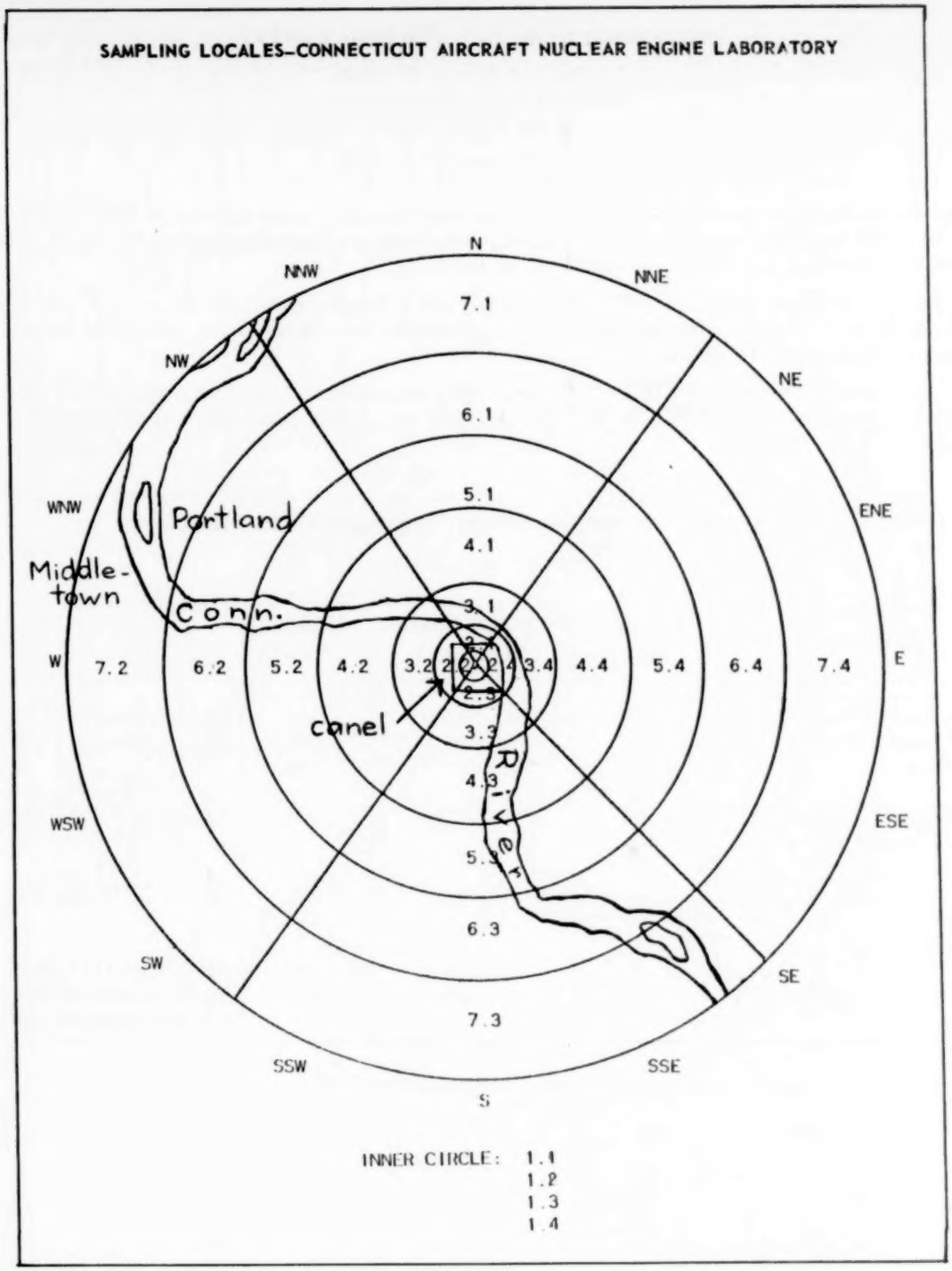

SAMPLING LOCALES–CONNECTICUT AIRCRAFT NUCLEAR ENGINE LABORATORY
N
NNW
NNE
NW
NE
WNW
ENE
W
E
WSW
ESE
SW
SE
SSW
SSE
S
7.1
6.1
5.1
4.1
3.1
7.2
6.2
5.2
4.2
3.2
3.4
4.4
5.4
6.4
7.4
6.3
7.3
Portland
Middle-
town
Conn.
canel
River
INNER CIRCLE: 1.1
1.2
1.3
1.4

FIGURE 1

NATIONAL REACTOR TESTING STATION

Health and Safety Division
Atomic Energy Commission
Idaho Falls, Idaho

Issued December 2, 1960

Environmental levels of radioactivity at the National Reactor Testing Station (NRTS) for 1959 and first quarter 1960 were reported in the December 1960 issue of Radiological Health Data. The following report presents the data for the second quarter of 1960.

The Health and Safety Division collects and analyzes a large number of water, air, milk and rabbit bone samples as part of their constant monitoring program (see figure 1 for sampling locations). The accompanying table presents the data.

The environmental monitoring data discloses that release of radioactive materials from NRTS operations during the second quarter was well below guide values recently adopted by the Federal Radiation Council.

TABLE 1.--ENVIRONMENTAL MONITORING DATA

Second Quarter 1960

Sample	Number stations	Approximate frequency	Number stations	Alpha	Beta
Off-site ground water.....	29	Bimonthly	34	<3 uuc/liter	<150 uuc/liter
On-site production well water	22	Weekly	209	<3 uuc/liter	<150 uuc/liter
Off-site air	10	Weekly	124	-	1 uuc/m^3
Perimeter ..... rabbit bones* (jack rabbit)	10	Quarterly	15	17 uuc Sr^{90}/gm Ca	
Off-site control..... rabbit bones (jack rabbit)*	10	Quarterly	19	21 uuc Sr^{90}/gm Ca	
Off-site milk	30	Monthly	60	<1000 uuc I^{131}/liter	
Off-site monitoring badges...	118	Monthly	354	β < 20 mrem/90 days γ < 20 mrem/90 days	

*Analysis for Sr^{90} in jack rabbit bones is for first quarter 1960.

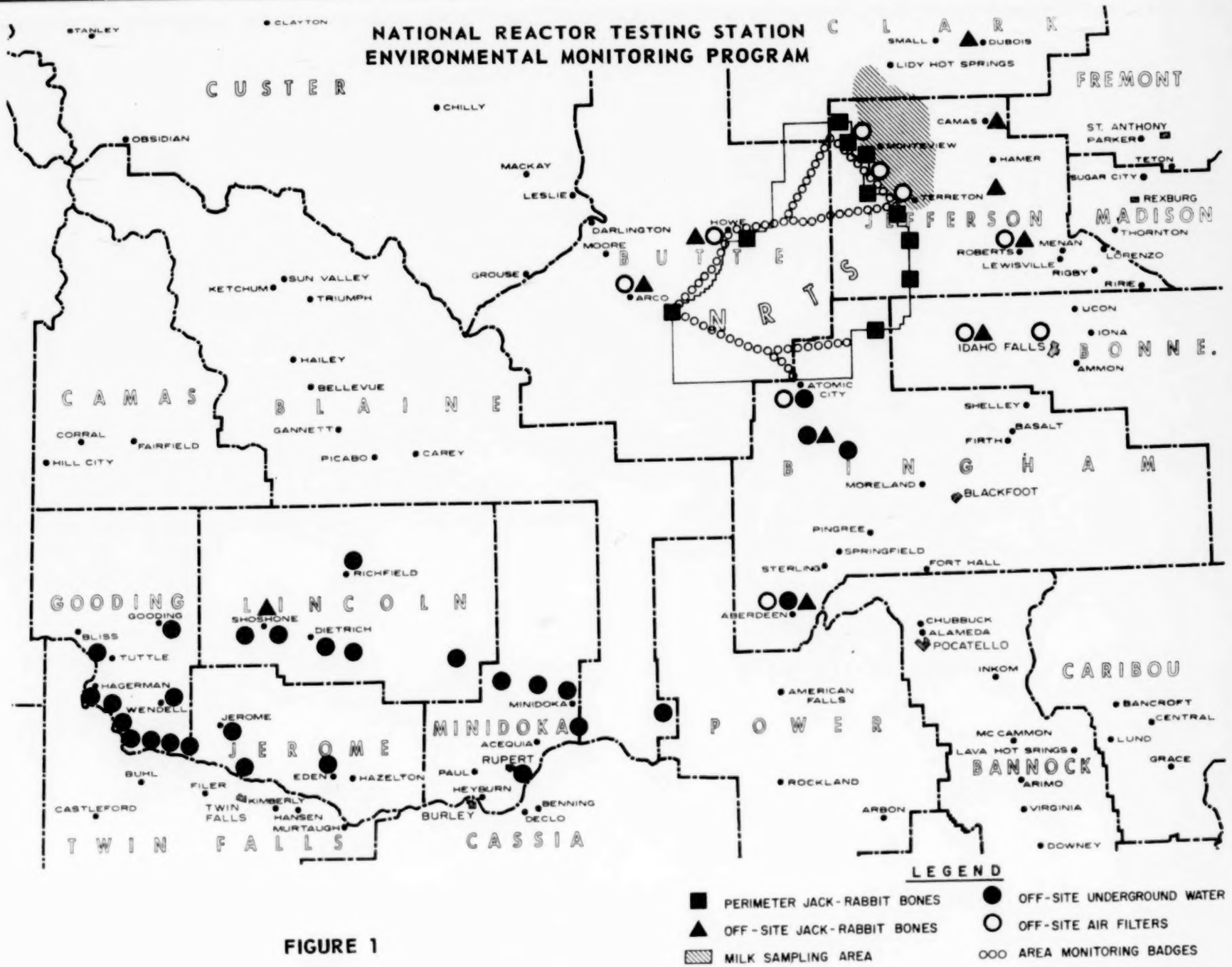


FIGURE 1

61145--U.S.Dept.of Comm--DC--1961